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1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

July 1991

COORDINATING RESEARCH COUNCIL, INC.
219 PERIMETER CENTER PARKWAY, ATLANTA, GEORGIA 30346

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1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

(CRC Project No. CM-123-90)

Prepared by the

1990 Analysis Panel

of the

CRC Octane Number Requirement Survey Group

July 1991

Automotive Vehicle Fuel, Lubricant, and Equipment Research Committee

of the

Coordinating Research Council, Inc.

ABSTRACT

An annual statistical survey of octane number requirements of current model vehicles is conducted by the Coordinating Research Council, Inc. Test data have been obtained by seventeen companies on 356 1990 vehicles including passenger cars and light-duty trucks and vans, of which 169 were equipped with knock sensors. Octane number requirements were determined by testing at maximum-throttle conditions, as well as at part-throttle, with three unleaded fuel series of varying sensitivities. Requirements are expressed as the (R+M)/2 octane number, Research octane number, and Motor octane number of the reference fuel producing knock which was recurrent and repeatable at the lowest audible level. Estimated octane number requirements for the total vehicles are weighted in proportion to the 1990 vehicle model production and/or sales figures. The octane number requirements of 1990 models with average sensitivity unleaded fuels were 85.4 (R+M)/2 octane numbers at the 50 percent satisfaction level, and 89.2 (R+M)/2 octane numbers at the 90 percent satisfaction level. Comparison with previous Surveys are made in this report.

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I. INTRODUCTION

This is the forty-fourth annual statistical survey of octane requirements of current model vehicles conducted by the Coordinating Research Council, Inc. This Survey studies distributions of vehicle octane requirements as a function of satisfaction levels and fuel sensitivity in a sample representative of 1990 model vehicles. Distributions of vehicle octane requirements are estimated from these data. The effect of fuel sensitivity, which is the difference between Research octane number (RON) and Motor octane number (MON), is investigated by using two full-boiling range fuel series and the primary reference fuel series. This is done because vehicles do not respond to RON and MON in the same way.

Knock sensors enable engines to adapt to fuels of varying octane numbers which can result in lowest audible knock occurring over a range of octane numbers; however, only the high end of this range is determined for each knock-sensor-equipped vehicle and used for the distribution calculations.

The data in this Survey are obtained by trained raters under controlled conditions. For some vehicles, information on the owner's perception of vehicle knock and the owner's current choice of gasoline octane are available. A comparison between the trained rater's and customer's report of knock on tank fuel is presented, and trends are shown.

Seventeen companies participated in this Survey; they are listed in Appendix A. Members of the CRC Octane Number Requirement Survey Analysis Panel are identified in Appendix B.

II. SUMMARY

Octane number requirements were determined on 356 1990 model year vehicles, including 266 passenger cars and 90 light-duty trucks and vans. One hundred sixty-nine of the test vehicles were equipped with knock sensors. Estimated octane number requirements for the vehicle populations are weighted in proportion to the 1990 vehicle model production and/or sales data. Octane number requirements for the 1990 models and changes from 1989 for the four weighted vehicle population groups at the 50 percent and 90 percent levels using FBRU (full-boiling range unleaded) fuels are summarized below:

FBRU (R+M)/2 OCTANE NUMBER REQUIREMENTS AND 95% CONFIDENCE LEVELS

1990 AND CHANGES FROM 1989

Weighted Population	Octane Requirement	▲ from 1989
50% Satisfaction		
Total Vehicles (47.5%)*	85.4 ± 0.3	0.3
Total Cars (41.0%)*	85.0 ± 0.4	0.2
Total Trucks (66.7%)*	85.8 ± 0.5	0.0
Total Knock-Sensor Vehicles	85.5 ± 0.5	0.1
90% Satisfaction		
Total Vehicles (47.5)*	89.2 ± 0.4	0.0
Total Cars (41.0)*	89.2 ± 0.6	0.0
Total Trucks (66.7)*	89.0 ± 0.7	-0.2
Total Knock-Sensor Vehicles	89.7 ± 0.6	0.0

* Percent of knock-sensor-equipped vehicles tested within the associated population.

Octane number requirements of the total 1990 vehicle population increased by 0.3 (R+M)/2 at 50 percent satisfaction and stayed the same at 90 percent satisfaction compared with 1989 on FBRU fuels. Octane requirements of 1990 knock-sensor vehicles increased by 0.1 (R+M)/2 at 50 percent and also did not change at 90 percent satisfaction compared with 1989. Changes in these distributions are not significant at the 95 percent confidence level.

Part-throttle octane requirements were equal to or higher than the maximum-throttle octane requirements on 23 percent of all 1990 vehicles with FBRU fuels (79 of 339 vehicles). This compares with 26 percent of all 1989 vehicles with part-throttle requirement on FBRU fuels.

In the 1990 Survey, 22 percent of the owner-operated vehicles tested knocked on tank fuel.

The 1990 Survey included sufficient data for nine specific models to be analyzed separately as select models. All select models had automatic transmissions, and six were equipped with knock sensors. Octane requirements for the select models at the 50 percent and 90 percent satisfaction levels for FBRU fuels are summarized in the following table.

SELECT MODELS

MAXIMUM FBRU OCTANE NUMBER REQUIREMENTS

		(R+M)/2	
Select Model	No. Tested	50% Sat.	90% Sat.
A	11	82.5	85.5
B	10	86.7	89.4
C	13	86.5	91.4
D	15	86.4	90.6
E	15	81.5	86.9
F	13	85.9	91.5
G	13	83.3	87.1
H	11	86.9	89.7
I	15	80.8	85.0

III. TEST VEHICLES

This year's Survey tested a total of 356 1990 model vehicles. The analysis of the data included 266 passenger cars and 90 light-duty trucks and vans. Also included are 169 knock sensor-equipped vehicles (109 cars and 60 trucks).

Beginning with the 1987 Survey, test vehicles are divided into four main categories:

(1) Total Vehicles, which includes all US and imported passenger cars and light-duty trucks and vans

(2) Total Cars, which includes all US and imported passenger cars

(3) Total Trucks, which includes all US and imported light-duty trucks and vans

(4) Total Knock-Sensor Vehicles, which includes all knock-sensor-equipped US and imported passenger cars and light-duty trucks and vans.

In the 1990 Survey, 87 percent of the transmissions were automatic. Thirty-four percent of the automatics were three-speeds, and the rest four-speeds. The manual transmissions were divided into 4 percent four-speeds, 94 percent five-speeds and 2 percent six-speeds. Ninety-seven percent of the surveyed vehicles were air-conditioned.

The select models shown in Table 1 include seven additional models not included in the program proposal (Table D-1 of Appendix D). Although not appearing as select models in the program proposal, these seven models are included as select models because ten or more vehicles per model were tested.

Table 2 shows the distribution of odometer mileage for both the 1990 and 1989 Surveys. The 1990 distribution is shown as a bar chart in Figure 1. The average odometer mileage was 11,782. The average displacement of those vehicles tested in 1990 was 3.1, compared with 3.0 in 1989. The average compression ratio of those vehicles tested in 1990 was 9.0, the same as in 1989.

Trends in the sales-weighted average compression ratio, engine displacement, and knock-sensor penetration for the US vehicle population over the last five model years are shown below. Also included are the percent of vehicles tested in this Survey which have automatic transmissions and air conditioners.

1990 ONR SURVEY TEST VEHICLE DATA

Average Vehicle Parameters

Model Year	Sales Weighted Displacement (liters)	Sales Weighted Compression Ratio	Sales Weighted % Knock Sensor	Percent of Vehicles Tested Automatic Transmissions	Percent of Vehicles Tested Air Conditioners
1990	3.1	9.0	42.9	87	97
1989	3.1	9.0	40.2	86	97
1988	3.0	9.0	39.6	82	92
1987	2.9	9.0	35.0	81	89
1986	3.0	9.0	35.5	84	94

The basic spark timing was adjusted to the manufacturer's recommended setting (within ±1°) prior to testing. A total of eight vehicles were adjusted; all were two or more degrees off from the manufacturer's setting. The number of vehicles and their deviation in spark setting are shown in Table 3.

Participants were requested to rate specific vehicle models in a pattern which would minimize data bias due to differences among testing laboratories and vehicles. To accomplish this, the United States and Canada were divided into four geographical areas, and companies within each geographical area were requested to test specific vehicles.

IV. REFERENCE FUELS

Three series of reference fuels were used in the 1990 Survey:

- Primary Reference (PR) Fuels
- Average Sensitivity Full-Boiling Range Unleaded (FBRU) Reference Fuels with sensitivities similar to those of commercial gasoline
- High-Sensitivity Full-Boiling Range Unleaded (FBRSU) Reference Fuels with sensitivities about two octane numbers higher than the FBRU fuels.

A. PR Fuels

Isooctane and normal heptane, meeting ASTM specifications, were blended in two octane number increments from 76 to 82 octane numbers, and in one octane number increments from 82 to 100 octane numbers.

B. FBRU Reference Fuels

FBRU fuels were prepared from three base blends (RMFD-368-89/90, RMFD-369-89/90, and RMFD-370-89/90) in two octane number increments from 80 to 84 RON, and in one octane number increments from 84 to 104 RON. The base blends were prepared from normal refinery components. Inspection data furnished by the supplier are shown in Appendix C, Table C-1. The composition and average laboratory octane data for the 1989/1990 FBRU reference fuel series are presented in Appendix C, Table C-2.

C. FBRSU Reference Fuels

FBRSU fuels were prepared from three base blends (RMFD-371-89/90 RMFD-372-89/90, and RMFD-373-89/90) in two octane number increments from 80 to 84 RON, and in one octane number increments from 84 to 103.5 RON. The base blends were prepared from normal refinery components. Inspection data furnished by the supplier are shown in Appendix C, Table C-3. The laboratory blending octane data for the 1989/199 FBRSU reference fuels are presented in Table C-4.

V. TEST TECHNIQUE

The test technique (CRC Designation E-15-90, Attachment 2 of Appendix D) specified that octane number requirements be determined at level road acceleration conditions. The order of fuel testing was tank fuel, FBRSU fuels, FBRU fuels, and PR fuels. Knocking tendencies were investigated using both maximum-throttle and part-throttle acceleration techniques.* Part-throttle was investigated in each vehicle to determine if the part-throttle requirement was higher or equal to the maximum-throttle requirement with all three fuel series. Part-throttle requirements were also determined with FBRU fuels down to four Research octane numbers below the requirement at maximum-throttle.

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* Maximum-throttle is either full-throttle for manual transmissions or widest throttle position (detent) that does not cause the transmission to downshift for automatic transmissions.

The octane number requirement of a vehicle is defined as the octane number of the highest octane test fuel producing borderline knock. This requirement is defined at either maximum- or part-throttle acceleration conditions. Requirements are expressed as the (R+M)/2 octane number, Research octane number (RON), and Motor octane number (MON) of the reference fuel which produces knock that is recurrent and repeatable at the lowest audible level.

Of the seventeen laboratories participating in the 1990 Survey, two used level roads and fifteen used chassis dynamometers. Eighty-eight percent of the vehicles were tested on chassis dynamometers.

Average test temperature was 74°F, with a barometric pressure average of 29.77 inches Hg and average humidity of 63 grains per pound. Test conditions for individual observations are reported in Appendix E.

The table below shows the average test conditions and the average odometer readings for the last five Surveys.

Average Ambient Test Conditions

Year	Temperature, F°	Barometric Pressure, inches Hg	Humidity, grains per pound	Mileage
1990	74	29.77	63	11782
1989	69	29.75	58	12772
1988	70	29.84	57	12407
1987	67	29.85	49	13720
1986	70	29.83	58	11849

There is general agreement that ambient temperature, pressure, and humidity can influence the octane number requirement of a vehicle at any time.[1,2] Octane requirement increases as temperature and pressure increase, and as humidity decreases. The coefficients of these effects are difficult to determine and may be dependent upon the vehicle.

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(1) B. D. Keller, J. H. Steury, T. O. Wagner, SAE Paper 780668 (1978)

(2) H. A, Bigley, Jr., B. D. Keller and M. G. Kloppe, SAE Paper 710675 (1971).

VI. DISCUSSION OF RESULTS

A. Distribution of Octane Number Requirements

The octane number requirement data were used to prepare satisfaction curves and tables for the following samples of 1990 model vehicles:

(1) Total Vehicles,
(2) Total Cars,
(3) Total Trucks,
(4) Total Knock-Sensor Vehicles.

(R+M)/2, RON, and MON requirements and 95 percent confidence limits for the four categories at 50 percent and 90 percent satisfaction are shown in Table 4. In preparing the curves and tables, the octane number requirement data were weighted in accordance with final 1990 model-year production and/or sales figures. Each curve and table, therefore, provides an estimate of the distribution of octane number requirements of the appropriate vehicle population on the road. The procedure for assigning weighting factors and for calculating the octane number requirement distributions is described in Appendix F.

Vehicles equipped with knock sensors were included in the 1990 models tested. All vehicles with knock sensors were tested for octane number requirements.

Requirements are expressed as the (R+M)/2, Research, and Motor octane numbers of the reference fuel which produced knock that was recurrent and repeatable at the lowest audible level.

Round-off techniques were changed beginning with the 1988 Survey, and are described in Appendix F.

1. Total Vehicles

In the 1990 Survey, octane number requirements were determined on 345 vehicles with PR fuels, 355 vehicles with FBRU fuels, and 356 vehicles with FBRSU fuels. One hundred sixty-nine of the vehicles were equipped with knock sensors.

(R+M)/2 octane number requirements for all three reference fuels are shown in Figures 2, 3, and 4. The (R+M)/2 octane number requirements for all three reference fuels are plotted in Figure 5. The octane number requirement distributions for FBRU and FBRSU fuels are similar. (R+M)/2, Research, and Motor octane number requirements are listed in Table 5. The 50 percent and 90 percent satisfaction level requirements are:

OCTANE NUMBER REQUIREMENTS

(Total Vehicles)

Fuel	50% Satisfied (R+M)/2	50% Satisfied RON	50% Satisfied MON	90% Satisfied (R+M)/2	90% Satisfied RON	90% Satisfied MON
PR	88.0	88.0	88.0	92.2	92.2	92.2
FBRU	85.4	89.3	81.5	89.2	93.9	84.0
FBRSU	85.0	90.0	80.0	89.1	95.0	83.3

Differences between 1990 and 1989 Survey maximum (R+M)/2, Research, and Motor octane number requirements are also shown in Table 5 for all three fuel series. Distributions of the 1990 and 1989 maximum (R+M)/2 requirements are shown in Figure 6 for FBRU fuels. The differences at the 50 percent and 90 percent satisfaction levels are:

DIFFERENCES BETWEEN 1990 AND 1989 OCTANE NUMBER REQUIREMENTS

(Total Vehicles)

Fuel	50% Satisfied (R+M)/2	50% Satisfied RON	50% Satisfied MON	90% Satisfied (R+M)/2	90% Satisfied RON	90% Satisfied MON
PR	0.2	0.2	0.2	0.5	0.5	0.5
FBRU	0.3	0.3	0.2	0.0	-0.1	-0.5
FBRSU	-0.1	-0.1	-0.1	-0.2	-0.2	-0.1

Confidence limits for octane number requirement distributions are given in Appendix G, Table G-1. The 95 percent confidence limits for (R+M)/2 octane number requirements were $\pm$0.3 to $\pm$0.4 at the 50 percent satisfaction level, and $\pm$0.4 to $\pm$0.5 at the 90 percent satisfaction level. The yearly difference at the 90 percent satisfaction level is significant at the 95 percent confidence level.

2. Total Cars

Octane number requirements were determined on 257 cars with PR fuels, 265 cars with FBRU fuels, and 266 cars with FBRSU fuels.

(R+M)/2, Research, and Motor octane number requirements on all three fuel series are given in Table 6. The (R+M)/2 octane number requirement distributions for all three reference fuel series are plotted in Figure 7. Octane number requirements at the 50 percent and 90 percent satisfaction levels are:

OCTANE NUMBER REQUIREMENTS

(Total Cars)

	50% Satisfied			90% Satisfied		
Fuel	(R+M)/2	RON	MON	(R+M)/2	RON	MON
PR	87.3	87.3	87.3	92.0	92.0	92.0
FBRU	85.0	88.8	81.2	89.2	94.0	84.5
FBRSU	84.8	89.8	79.9	89.3	95.1	83.4

Differences between the 1990 and 1989 Survey (R+M)/2, Research and Motor octane number requirements are also shown in Table 6 for PR, FBRU, and FBRSU fuels. Distributions of the 1990 and 1989 (R+M)/2 requirements are shown in Figure 8 for FBRU fuels. Differences between 1990 and 1989 data at the 50 percent and 90 percent satisfaction levels are:

DIFFERENCES BETWEEN 1990 AND 1989
OCTANE NUMBER REQUIREMENTS

(Total Cars)

	50% Satisfied			90% Satisfied		
Fuel	(R+M)/2	RON	MON	(R+M)/2	RON	MON
PR	0.0	0.0	0.0	-0.1	-0.1	-0.1
FBRU	+0.2	+0.3	0.2	0.0	0.0	0.0
FBRSU	0.0	0.1	0.1	-0.2	-0.3	-0.2

Confidence limits for octane number requirement distributions of 1990 total cars are given in Appendix G, Table G-1. The 95 percent confidence limits for (R+M)/2 requirements were between ±0.4 and ±0.5 at the 50 percent satisfaction level, and ±0.6 at the 90 percent satisfaction level. The yearly changes for the total car population are not significant at the 95 percent confidence level.

3. Total Trucks

Octane number requirements were determined on 88 light-duty trucks and vans with PR fuels, and 90 with FBRU and FBRSU fuels. (R+M)/2 octane number requirements for all three reference fuel series are plotted in Figure 9. (R+M)/2, Research, and Motor octane number requirements on all three fuel series are given in Table 7. The 50 percent and 90 percent satisfaction level octane number requirements are:

OCTANE NUMBER REQUIREMENTS

(Total Trucks)

	50% Satisfied			90% Satisfied		
Fuel	(R+M)/2	RON	MON	(R+M)/2	RON	MON
PR	88.9	88.9	88.9	92.4	92.4	92.4
FBRU	85.8	89.8	81.8	89.0	93.7	84.3
FBRSU	85.3	90.4	80.2	88.9	94.7	83.1

Differences between the (R+M)/2, Research, and Motor octane number requirements of trucks in the 1990 and 1989 Surveys are also given in Table 7 for all three fuel series. The differences at the 50 percent and 90 percent satisfaction levels are:

DIFFERENCES BETWEEN 1990 AND 1989
OCTANE NUMBER REQUIREMENTS

(Total Trucks)

	50% Satisfied			90% Satisfied		
Fuel	(R+M)/2	RON	MON	(R+M)/2	RON	MON
PR	0.9	0.9	0.9	-0.9	-0.9	-0.9
FBRU	0.0	0.0	0.0	-0.2	-0.3	-0.2
FBRSU	-0.3	-0.3	-0.2	-0.2	-0.2	-0.1

Distributions of the 1990 and 1989 (R+M)/2 requirements are shown in Figure 10 for FBRU fuels.

Confidence limits for octane number requirement distributions of 1990 trucks are tabulated in Appendix G, Table G-1. The 95 percent confidence limits for (R+M)/2 octane number requirements varied from ±0.5 to ±0.6 at the 50 percent satisfaction level, and from ±0.7 to ±0.8 at the 90 percent satisfaction level. The yearly differences for the truck population for PR fuels ar both 50 percent and 90 percent satisfaction are significant at the 95 percent confidence level.

4. Total Knock-Sensor Vehicles

Octane number requirements were determined on 166 vehicles containing knock sensors with PR fuels, and 168 vehicles with FBRU fuels and 169 vehicles with FBRSU fuels.

The distributions of (R+M)/2 octane number requirements are shown in Figure 11 for the three fuel series. (R+M)/2, Research, and Motor octane number requirements for all three fuel series are given in Table 8. Octane number requirements for the 50 percent and 90 percent satisfaction levels are:

OCTANE NUMBER REQUIREMENTS

(Total Knock-Sensor Vehicles)

	50% Satisfied			90% Satisfied		
Fuel	(R+M)/2	RON	MON	(R+M)/2	RON	MON
PR	88.1	88.1	88.1	92.2	92.2	92.2
FBRU	85.5	89.5	81.6	89.7	94.5	84.9
FBRSU	85.0	90.0	80.0	89.5	95.4	83.6

Differences between 1990 and 1989 Survey (R+M)/2, Research, and Motor octane number requirements are also shown in Table 8. Distributions of (R+M)/2 octane number requirements are shown in Figure 12 for FBRU fuels. The differences at the 50 percent and 90 percent satisfaction levels are:

DIFFERENCES BETWEEN 1990 AND 1989
OCTANE NUMBER REQUIREMENTS

(Total Knock-Sensor Vehicles)

	50% Satisfied			90% Satisfied		
Fuel	(R+M)/2	RON	MON	(R+M)/2	RON	MON
PR	-0.2	-0.2	-0.2	-1.5	-1.5	-1.5
FBRU	+0.1	0.2	0.1	0.0	0.0	0.0
FBRSU	-0.4	-0.5	-0.3	-0.2	-0.2	-0.1

Confidence limits for octane number requirement distributions of 1990 knock-sensor vehicles are given in Appendix G, Table G-1. The 95 percent confidence limits for (R+M)/2 octane number requirements varied between $\pm$0.4 and $\pm$0.5 at the 50 percent satisfaction level, and between $\pm$0.6 and $\pm$0.7 at the 90 percent satisfaction level.

The yearly difference for the total knock-sensor vehicle population for PR fuels at the 90 percent satisfaction level is significant at the 95 percent confidence level.

B. Octane Number Requirement Trends

Trends over the last five years in the sales-weighted octane number requirements of the four vehicle categories analyzed in this report are given in the following table:

FBRU (R+M)/2 OCTANE NUMBER REQUIREMENTS

1986 TO 1990

Weighted Population	1990	1989	1988	1987	1986
	50% Satisfaction				
Total Vehicles	85.4	85.1	84.7	85.7	85.3
Total Cars	85.0	84.8	84.7	85.4	85.0
Total Trucks	85.8	85.8	84.8	86.3	86.9*
Total Knock-Sensor Vehicles	85.5	85.4	85.0	86.6	85.4
	90% Satisfaction				
Total Vehicles	89.2	89.2	89.3	90.5	89.8
Total Cars	89.2	89.2	89.2	90.4	89.5
Total Trucks	89.0	89.2	89.6	91.6	90.3*
Total Knock-Sensor Vehicles	89.7	89.7	90.2	91.9	90.2

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*The total trucks octane number requirements for 1986 were estimated from the percent satisfaction distributions for total vehicles and total cars.

C. Part-Throttle Requirements

Part-throttle octane requirements were equal to or higher than the maximum-throttle octane requirements on 23 percent of all 1990 vehicles with FBRU fuels (79 of 339 vehicles). This compares with 26 percent in 1989.

D. Select Models

Select models, representing nine engine-transmission-chassis combinations, were tested. The select models tested in this year's Survey included six knock-sensor-equipped models. The specifications of the engine-chassis combinations of the select models are in Table 1.

Octane number requirements for each select model at various satisfaction levels are listed in Tables 9 through 13.

E. Tank Fuel

Tank fuel was tested for incidence of knock on all vehicles. Owners' questionnaires, however, were obtained only when the vehicle tested had a regular driver and the spark timing was not reset.

1. Owner/Rater Comparisons of Tank Fuel Knock

For 101 vehicles, both owner and rater data were reported, and no adjustments of spark timing were made. The trained raters reported that 22 percent of the owner-operated vehicles knocked, while the owners reported that 4 percent knocked, an owner/rater knock ratio of 0.18. The 22 percent of vehicles found to be knocking by trained raters does not compare with 31 percent for the 1989 Survey, because in 1990, only owner-operated vehicles were counted. These owner/rater comparisons of tank fuel knock for 1990, along with previous Survey data back to 1983, are presented in Table 18.

Tank fuel Research and Motor octane number data were reported for a total of 69 vehicles with both owner/rater data and no adjustments of spark timing. Fifty vehicles were reported to have tank fuel octane numbers less than 91.0 (R+M)/2. Trained observers reported knock on 32 percent of these, compared with 2 percent for owners. Of the other 19 vehicles having tank fuels greater than or equal to 91.0 (R+M)/2, none knocked according to trained raters, and no owners reported knock.

2. Objectionable Versus Non-Objectionable Knock

Of the owners reporting tank-fuel knock with vehicles which had no change in spark timing, 20 percent found the knock to be objectionable, as compared to 10 percent in the 1989 Survey. Comparisons of objectionable knock for the 1983 through 1990 Surveys are also given in Table 18.

3. Tank Fuel Knock Reported by Trained Raters

Tank fuel knock observations were reported for 103 of the 356 vehicles tested. The percentages of all 1990 vehicles knocking on tank fuel are shown in Table 19. Knock was observed on 18 percent of the 1990 vehicles tested, compared with 30 percent in the 1989 Survey.

The percentages of select models knocking on tank fuel are shown in Table 9 to 17 and varied from a low of 0 percent to a high of 40 percent.

F. Engine Speed for Octane Number Requirements

Engine speeds at which octane number requirements occurred for each select model are shown in Tables 9 to 17 for PR, FBRU, and FBRSU fuels. Weighted data for all 1990 vehicles are shown in Table 20.

G. Gear Position for Octane Number Requirements

The throttle/gear position for octane number requirements on FBRU fuels is shown in Table 21. Of the 356 vehicles tested, 311 (87 percent) were equipped with automatic transmissions and 45 (13 percent) were equipped with manual transmissions.

Requirements at maximum-throttle occurred in 80 percent of the automatic transmission vehicles (19 percent in fourth gear, 35 percent in third gear, and 19 percent in second gear). Requirements at part-throttle occurred in 20 percent of the automatic transmission vehicles (7 percent in fourth gear, 12 percent in third gear, and 1 percent in second gear).

For manual transmission vehicles, 69 percent had requirements at maximum-throttle (43 percent in fourth gear and 26 percent in third gear) Requirements at part-throttle occurred in 31 percent of manual transmission vehicles (26 percent in fourth gear, and 5 percent in third gear). Fifth gear for five-speed and six-speed manual transmissions was not examined per program instructions.

TABLES

and

FIGURES

TABLE 1

1990 SELECT MODEL SPECIFICATIONS

Model	Knock Sensor	Disp. (L)	Engine Type	System Type *	Fuel Comp. Ratio	Brake HP	Trans-mission
A	-	3.0	V6	MFI	8.9	141	A4
B	KS	3.0	V6	MFI	9.3	140	A4
C	-	3.8	V6	MFI	9.0	140	A4
D	-	2.2	L4	TBI	9.0	95	A3
E	KS	3.8	V6	MFI	8.5	165	A4
F	KS	3.1	V6	MFI	8.8	135	A3
G	KS	3.1	V6	MFI	8.8	135	A3
H	KS	5.7	V8	TBI	9.1	210	A4
I	KS	3.3	V6	MFI	8.9	150	A4

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* TBI = Throttle Body Fuel Injection;

MFI = Port Fuel Injection;

Individual manufacturers may use different abbreviations.

TABLE 2

DISTRIBUTION OF ODOMETER MILEAGE

FOR TESTED VEHICLES

	No. of Vehicles Within Mileage Increments	
Mileage	1990 Vehicles	1989 Vehicles
0 - 1,999	0	0
2,000 - 3,999	0	0
4,000 - 5,999	1	0
6,000 - 7,999	76	85
8,000 - 9,999	86	72
10,000 - 11,999	65	51
12,000 - 13,999	39	35
14,000 - 15,999	32	47
16,000 - 17,999	15	39
18,000 - 19,999	13	20
20,000 - 24,999	20	29
25,000 - 29,999	8	11
30,000 +	1	2
No. of Vehicles	356	391
Average Mileage	11,782	12,773

TABLE 3

1990 BASIC SPARK TIMING ADJUSTMENTS

Degrees From Manufacturer's Setting	No. of Vehicles	
	+	-
1	0	0
2	1	2
3	1	0
4	0	0
5	0	0
6	1	0
7	1	0
8	0	0
9	0	1
10	0	1
11+	0	0
	4	4

Total vehicles adjusted	8
Total vehicles not adjusted	220
Total vehicles with timing not adjustable	128

TABLE 4

OCTANE NUMBER REQUIREMENTS WITH 95% CONFIDENCE LIMITS

	Fuel	No. Vehicles	(R+M)/2		Research Octane No.		Motor Octane No.	
			50% Sat.	90% Sat.	50% Sat.	90% Sat.	50% Sat.	90% Sat.
Total Vehicles	PR	345	88.0±0.4	92.2±0.5	88.0±0.4	92.2±0.5	88.0±0.4	92.2±0.5
	FBRU	355	85.4±0.3	89.2±0.4	89.3±0.4	93.9±0.3	89.3±0.2	84.4±0.4
	FBRSU	356	85.0±0.3	89.1±0.4	90.0±0.4	95.0±0.6	80.0±0.3	83.3±0.4
Total Cars	PR	257	87.3±0.5	92.0±0.6	87.3±0.5	92.0±0.6	87.3±0.5	92.0±0.6
	FBRU	265	85.0±0.4	89.2±0.6	88.8±0.5	94.0±0.7	81.2±0.3	84.5±0.4
	FBRSU	266	84.8±0.4	89.3±0.6	89.8±0.5	95.1±0.7	79.9±0.3	83.4±0.4
Total Trucks and Vans	PR	88	88.9±0.6	92.4±0.8	88.9±0.6	92.4±0.8	88.9±0.6	92.4±0.8
	FBRU	90	85.8±0.5	89.0±0.7	89.8±0.6	93.7±0.8	81.8±0.4	84.3±0.6
	FBRSU	90	85.3±0.6	88.9±0.8	90.4±0.7	94.7±1.0	80.2±0.5	83.1±0.6
Total Knock-Sensor Vehicles	PR	166	89.0±0.5	92.2±0.6	89.0±0.5	92.2±0.6	89.0±0.5	92.2±0.6
	FBRU	168	85.5±0.4	89.7±0.6	89.5±0.6	94.5±0.7	81.6±0.4	84.9±0.5
	FBRSU	169	85.0±0.5	89.5±0.7	90.0±0.6	95.4±0.9	80.0±0.4	83.6±0.6

TABLE 5

OCTANE NUMBER REQUIREMENTS - 1990 TOTAL VEHICLES

Percent Satisfied	PR Fuels		FBRU Fuels						FBRSU Fuels					
			(R+M)/2		RON		MON		(R+M)/2		RON		MON	
	1990	Diff. 1989	1990	Diff. 1989	1990	Diff. 1989	1990	Diff. 1989	1990	Diff. 1989	1990	Diff. 1989	1990	Diff. 1989
10	81.8	-1.6	80.5	-0.5	83.3	-0.6	77.6	-0.4	80.4	-0.4	84.6	-0.5	76.3	-0.3
20	84.5	-0.3	82.2	-0.3	85.5	-0.2	79.0	-0.2	82.0	-0.2	86.4	-0.3	77.5	-0.2
30	85.7	-0.2	83.4	0.0	86.8	-0.1	79.9	-0.1	83.3	0.2	87.9	0.1	78.6	0.1
40	86.8	-0.1	84.4	0.1	88.1	0.2	80.8	0.2	84.2	0.2	89.0	0.2	79.3	0.1
50	88.0	0.2	85.4	0.3	89.3	0.3	81.5	0.2	85.0	-0.1	90.0	-0.1	80.0	-0.1
60	89.0	0.2	86.2	0.3	90.3	0.3	82.1	0.2	85.9	0.0	91.1	-0.1	80.7	0.0
70	89.9	0.0	87.0	0.1	91.3	0.2	82.8	0.1	86.7	-0.1	92.1	-0.1	81.2	-0.1
80	90.8	-0.1	87.9	0.0	92.4	0.1	83.5	0.0	87.7	-0.2	93.3	-0.3	82.1	-0.2
90	92.2	-0.5	89.2	0.0	93.9	-0.1	84.4	-0.1	89.1	-0.2	95.0	-0.2	83.3	-0.1
95	93.4	-0.7	90.5	0.0	95.5	0.1	85.5	0.0	90.5	-0.2	96.6	-0.2	84.4	-0.2
98	94.7	-1.1	93.0	0.1	98.4	0.1	87.6	0.1	92.8	-0.2	99.1	-0.3	86.4	-0.3
99	95.7	-1.4	94.0	0.2	99.5	0.2	88.4	0.1	94.7	0.8	101.3	0.9	88.2	0.7

TABLE 6

OCTANE NUMBER REQUIREMENTS - 1990 TOTAL CARS

Percent Satisfied	PR Fuels		FBRU Fuels						FBRSU					
			(R+M)/2		RON		MON		(R+M)/2		RON		MON	
	1990	Diff. 1989	1990	Diff. 1989	1990	Diff. 1989	1990	Diff. 1989	1990	Diff. 1989	1990	Diff. 1989	1990	Diff. 1989
10	81.1	-2.0	79.4	-0.9	82.0	-1.2	76.7	-0.8	79.6	-0.8	83.6	-1.0	75.7	-0.6
20	83.5	-1.0	81.8	-0.4	84.9	-0.5	78.7	-0.3	81.6	-0.4	86.0	-0.5	77.2	-0.3
30	85.1	-0.5	83.0	-0.1	86.3	-0.2	79.6	-0.1	82.8	-0.1	87.4	-0.1	78.2	-0.1
40	86.2	-0.3	84.0	0.0	87.6	0.1	80.4	0.0	83.8	0.1	88.6	0.1	79.0	0.1
50	87.3	0.0	85.0	0.2	88.8	0.3	81.2	0.2	84.8	0.0	89.8	0.1	79.9	0.1
60	88.5	0.3	86.1	0.5	90.1	0.5	82.0	0.4	85.8	0.0	91.0	0.1	80.6	0.0
70	89.7	0.5	87.0	0.5	91.3	0.7	82.8	0.5	86.8	0.3	92.2	0.3	81.3	0.2
80	90.7	0.4	88.0	0.4	92.4	0.4	83.6	0.3	87.8	0.2	93.4	0.2	82.2	0.2
90	92.0	-0.1	89.2	0.0	94.0	0.0	84.5	0.0	89.3	-0.2	95.1	-0.3	83.4	-0.2
95	93.3	-0.4	90.9	-0.2	96.0	-0.1	85.9	-0.1	90.7	-0.7	96.9	-0.8	84.6	-0.6
98	94.7	-0.9	93.2	0.0	98.7	0.0	87.8	0.0	93.3	-0.1	99.8	-0.1	86.9	-0.1
99	95.6	-1.2	94.3	0.3	99.8	0.3	88.7	0.3	95.7	1.5	102.3	1.5	89.1	1.4

TABLE 7

OCTANE NUMBER REQUIREMENTS - 1990 TOTAL TRUCKS AND VANS

Percent Satisfied	PR Fuels		FBRU Fuels						FBRSU					
			(R+M)/2		RON		MON		(R+M)/2		RON		MON	
	1990	Diff. 1989	1990	Diff 1989	1990	Diff. 1989	1990	Diff. 1989	1990	Diff. 1989	1990	Diff. 1989	1990	Diff. 1989
10	84.6	0.6	81.8	0.1	85.0	0.2	78.7	0.1	81.3	0.0	85.7	0.0	77.0	0.0
20	86.0	0.5	83.1	0.0	86.5	-0.1	79.7	0.0	83.0	0.2	87.6	0.2	78.3	0.1
30	87.0	0.0	84.2	0.1	87.8	0.0	80.6	0.1	84.0	0.3	88.8	0.3	79.1	0.2
40	88.1	0.1	85.2	0.2	89.0	0.2	81.3	0.1	84.6	-0.1	89.5	-0.1	79.7	0.0
50	88.9	-0.1	85.8	0.0	89.8	0.0	81.8	0.0	85.3	-0.3	90.4	-0.3	80.2	-0.2
60	89.5	-0.7	86.4	-0.3	90.5	-0.4	82.3	-0.2	86.0	-0.4	91.2	-0.5	80.7	-0.3
70	90.1	-0.9	87.0	-0.5	91.2	-0.6	82.8	-0.3	86.5	-0.9	91.9	-1.0	81.1	-0.7
80	90.9	-1.1	87.8	-0.5	92.2	-0.6	83.4	-0.4	87.4	-0.8	93.0	-0.9	81.9	-0.6
90	92.4	-1.1	89.0	-0.2	93.7	-0.3	84.3	-0.2	88.9	-0.2	94.7	-0.2	83.1	-0.1
95	93.5	-1.0	89.9	0.1	94.8	0.2	85.1	0.2	90.0	0.0	95.9	-0.1	84.0	0.0
98	****	****	92.1	0.7	97.3	0.8	86.8	0.5	92.0	0.3	98.3	0.3	85.7	0.2
99	****	0.0	93.6	0.5	99.1	0.6	88.1	0.4	92.8	-0.1	99.1	-0.1	86.4	-0.1

TABLE 8

OCTANE NUMBER REQUIREMENTS - 1990 TOTAL KNOCK-SENSOR VEHICLES

	PR Fuels		FBRU Fuels						FBRSU Fuels					
			(R+M)/2		RON		MON		(R+M)/2		RON		MON	
Percent Satisfied	1990	Diff. 1989	1990	Diff. 1989	1990	Diff. 1989	1990	Diff. 1989	1990	Diff. 1989	1990	Diff. 1989	1990	Diff. 1989
10	80.2	-2.4	79.3	-0.6	82.0	-0.6	76.7	-0.4	79.3	-0.9	83.2	-1.1	75.4	-0.7
20	83.1	-1.8	82.1	-0.2	85.3	-0.3	78.9	-0.2	81.8	-0.3	86.2	-0.4	77.4	-0.3
30	85.4	-0.7	83.4	-0.2	86.9	-0.3	80.0	-0.1	83.2	-0.2	87.9	-0.3	78.5	-0.2
40	86.8	-0.4	84.5	-0.1	88.2	-0.1	80.8	-0.1	84.1	-0.3	88.9	-0.4	79.3	-0.2
50	88.1	-0.2	85.5	0.1	89.5	0.2	81.6	0.1	85.0	-0.4	90.0	-0.5	80.0	-0.3
60	89.0	-0.4	86.3	0.0	90.5	0.0	82.2	0.0	86.0	-0.3	91.2	-0.4	80.7	-0.2
70	89.8	-0.7	87.1	-0.5	91.3	-0.6	82.8	-0.5	86.6	-0.9	92.0	-1.1	81.2	-0.8
80	90.7	-1.1	87.9	-0.6	92.3	-0.8	83.5	-0.5	87.6	-0.8	93.2	-1.0	82.0	-0.7
90	92.2	-1.5	89.7	0.0	94.5	0.0	84.9	0.0	89.5	-0.2	95.4	-0.2	83.6	-0.1
95	93.4	-1.4	90.6	-1.2	95.6	-1.4	85.7	-0.9	90.8	-1.2	96.9	-1.3	84.7	-1.0
98	95.1	-1.5	92.2	-1.3	97.5	-1.4	87.0	-1.0	92.1	-1.4	98.4	-1.5	85.8	-1.2
99	96.9	****	93.5	-0.9	99.0	-1.0	88.0	-0.8	92.6	-1.4	99.0	-1.5	86.3	-1.2

TABLE 9

OCTANE NUMBER REQUIREMENTS - 1990 SELECT MODELS

Select Model : A

Percent Satisfied	PR	FBRU			FBRSU		
	ON	RON	MON	(R+M)/2	RON	MON	(R+M)/2
5	79.7	81.1	76.2	78.6	83.1	75.2	79.2
10	80.7	82.1	76.8	79.5	84.0	75.9	79.9
20	82.0	83.4	77.7	80.5	85.1	76.6	80.9
30	82.8	84.3	78.2	81.3	85.9	77.1	81.5
40	83.6	85.1	78.7	81.9	86.6	77.6	82.1
50	84.3	85.8	79.2	82.5	87.2	78.0	82.6
60	85.0	86.5	79.7	83.1	87.9	78.5	83.2
70	85.7	87.3	80.2	83.7	88.5	78.9	83.7
80	86.6	88.2	80.7	84.5	89.3	79.5	84.4
90	87.8	89.4	81.5	85.5	90.4	80.2	85.3
95	88.8	90.4	82.2	86.3	91.3	80.8	86.1
N	11	11	11	11	11	11	11
Mean	84.3	85.8	79.2	82.5	87.2	78.0	82.6
Estimated Std. Dev. of the Sample Population	2.8	2.8	1.8	2.3	2.5	1.7	2.1
t	2.23	2.23	2.23	2.23	2.23	2.23	2.23
95% Confidence Limits:							
@ 50% Satisfied	1.9	1.9	1.2	1.6	1.7	1.1	1.4
@ 90% Satisfied	2.6	2.6	1.7	2.2	2.3	1.6	1.9

SPEED RANGE FOR OCTANE NUMBER REQUIREMENTS

SPEED RANGE	PR	FBRU	FBRSU
1599 and Lower	0	0	0
1600 - 1999	10	10	0
2000 - 2399	20	20	10
2400 - 2799	70	60	60
2800 - 3199	0	10	30
3200 and Higher	0	0	0

% Select Model Knocking on Tank Fuel = 0.0
Number of Test Vehicles = 11
Vehicles rated on Tank Fuel = 4

TABLE 10

OCTANE NUMBER REQUIREMENTS - 1990 SELECT MODELS

Select Model : B

Percent Satisfied	PR ON	FBRU RON	FBRU MON	FBRU (R+M)/2	FBRSU RON	FBRSU MON	FBRSU (R+M)/2
5	84.9	86.7	79.9	83.3	86.7	77.7	82.2
10	85.9	87.6	80.5	84.0	87.8	78.4	83.1
20	87.0	88.7	81.2	85.0	89.0	79.3	84.2
30	87.9	89.6	81.7	85.6	90.0	79.9	84.9
40	88.6	90.3	82.2	86.2	90.8	80.4	85.6
50	89.2	90.9	82.6	86.7	91.5	80.9	86.2
60	89.9	91.5	83.0	87.3	92.2	81.4	86.8
70	90.6	92.2	83.4	87.8	93.0	81.9	87.5
80	91.5	93.1	84.0	88.5	94.0	82.6	88.3
90	92.6	94.2	84.7	89.4	95.2	83.4	89.3
95	93.6	95.1	85.3	90.2	96.3	84.1	90.2
N	10	10	10	10	10	10	10
Mean	89.2	90.9	82.6	86.7	91.5	80.9	86.2
Estimated Std. Dev. of the Sample Population	2.6	2.6	1.6	2.1	2.9	2.0	2.4
t	2.26	2.26	2.26	2.26	2.26	2.26	2.26
95% Confidence Limits:							
@ 50% Satisfied	1.9	1.8	1.2	1.5	2.1	1.4	1.7
@ 90% Satisfied	2.6	2.5	1.6	2.1	2.9	1.9	2.4

SPEED RANGE FOR OCTANE NUMBER REQUIREMENTS

SPEED RANGE	PR	FBRU	FBRSU
1599 and Lower	10	20	30
1600 - 1999	70	40	20
2000 - 2399	20	20	10
2400 - 2799	0	0	10
2800 - 3199	0	10	10
3200 and Higher	0	10	20

% Select Model Knocking on Tank Fuel = 0.0
Number of Test Vehicles = 10
Vehicles rated on Tank Fuel = 1

TABLE 11

OCTANE NUMBER REQUIREMENTS - 1990 SELECT MODELS

Select Model : C

Percent Satisfied	PR ON	FBRU RON	FBRU MON	FBRU (R+M)/2	FBRSU RON	FBRSU MON	FBRSU (R+M)/2
5	83.5	83.1	77.5	80.3	84.7	76.3	80.5
10	84.8	84.8	78.6	81.7	86.4	77.4	81.9
20	86.3	86.8	79.9	83.3	88.3	78.8	83.6
30	87.4	88.2	80.8	84.5	89.7	79.8	84.8
40	88.3	89.5	81.7	85.6	90.9	80.6	85.8
50	89.2	90.7	82.4	86.5	92.1	81.4	86.7
60	90.1	91.8	83.2	87.5	93.2	82.2	87.7
70	91.0	93.1	84.0	88.5	94.4	83.0	88.7
80	92.1	94.5	84.9	89.7	95.8	84.0	89.9
90	93.6	96.5	86.2	91.4	97.8	85.3	91.6
95	94.9	98.2	87.3	92.8	99.4	86.4	92.9
N	13	13	13	13	13	13	13
Mean	89.2	90.7	82.4	86.5	92.1	81.4	86.7
Estimated Std. Dev. of the Sample Population	3.5	4.6	3.0	3.8	4.5	3.1	3.8
t	2.18	2.18	2.18	2.18	2.18	2.18	2.18
95% Confidence Limits:							
@ 50% Satisfied	2.1	2.8	1.8	2.3	2.7	1.9	2.3
@ 90% Satisfied	2.9	3.8	2.5	3.1	3.7	2.6	3.1

SPEED RANGE FOR OCTANE NUMBER REQUIREMENTS

SPEED RANGE	PR	FBRU	FBRSU
1599 and Lower	8	8	8
1600 - 1999	8	15	8
2000 - 2399	15	8	8
2400 - 2799	31	8	23
2800 - 3199	38	53	30
3200 and Higher	0	8	23

% Select Model Knocking on Tank Fuel = 25.0
Number of Test Vehicles = 13
Vehicles rated on Tank Fuel = 4

TABLE 12

OCTANE NUMBER REQUIREMENTS - 1990 SELECT MODELS

Select Model : D

Percent Satisfied	PR ON	FBRU RON	FBRU MON	FBRU (R+M)/2	FBRSU RON	FBRSU MON	FBRSU (R+M)/2
5	82.5	83.9	78.0	81.0	85.7	77.1	81.4
10	83.6	85.4	78.9	82.1	86.9	77.9	82.4
20	84.8	87.1	80.1	83.6	88.4	78.9	83.6
30	85.8	88.4	80.9	84.6	89.4	79.6	84.5
40	86.5	89.4	81.6	85.5	90.3	80.2	85.2
50	87.3	90.4	82.3	86.4	91.2	80.7	85.9
60	88.0	91.4	82.9	87.2	92.0	81.3	86.6
70	88.8	92.5	83.6	88.1	92.9	81.9	87.4
80	89.7	93.8	84.5	89.1	93.9	82.6	88.3
90	91.0	95.5	85.6	90.6	95.4	83.6	89.5
95	92.0	96.9	86.6	91.7	96.6	84.4	90.5
N	15	15	15	15	15	15	15
Mean	87.3	90.4	82.3	86.4	91.2	80.7	85.9
Estimated Std. Dev. of the Sample Population	2.9	3.9	2.6	3.3	3.3	2.2	2.8
t	2.14	2.14	2.14	2.14	2.14	2.14	2.14
95% Confidence Limits:							
@ 50% Satisfied	1.6	2.2	1.4	1.8	1.8	1.2	1.5
@ 90% Satisfied	2.2	3.0	2.0	2.5	2.5	1.7	2.1

SPEED RANGE FOR OCTANE NUMBER REQUIREMENTS

SPEED RANGE	PR	FBRU	FBRSU
1599 and Lower	7	13	20
1600 - 1999	39	20	7
2000 - 2399	20	7	13
2400 - 2799	7	7	7
2800 - 3199	27	53	53
3200 and Higher	0	0	0

% Select Model Knocking on Tank Fuel = 0.0
Number of Test Vehicles = 15
Vehicles rated on Tank Fuel = 1

TABLE 13

OCTANE NUMBER REQUIREMENTS - 1990 SELECT MODELS

Select Model : E

Percent Satisfied	PR ON	FBRU RON	FBRU MON	FBRU (R+M)/2	FBRSU RON	FBRSU MON	FBRSU (R+M)/2
5	74.1	76.4	72.8	74.6	77.0	71.1	74.0
10	75.7	78.3	74.1	76.2	78.9	72.4	75.6
20	77.6	80.5	75.5	78.0	81.1	73.9	77.5
30	78.9	82.0	76.6	79.3	82.8	75.0	78.9
40	80.1	83.4	77.5	80.5	84.2	76.0	80.1
50	81.2	84.7	78.4	81.5	85.5	76.9	81.2
60	82.3	85.9	79.2	82.6	86.8	77.8	82.3
70	83.5	87.3	80.2	83.7	88.2	78.7	83.5
80	84.8	88.9	81.2	85.1	89.9	79.8	84.9
90	86.7	91.1	82.7	86.9	92.1	81.4	86.8
95	88.3	92.9	83.9	88.4	94.0	82.7	88.3
N	15	15	15	15	15	15	15
Mean	81.2	84.7	78.4	81.5	85.5	76.9	81.2
Estimated Std. Dev. of the Sample Population	4.3	5.0	3.4	4.2	5.2	3.5	4.3
t	2.14	2.14	2.14	2.14	2.14	2.14	2.14
95% Confidence Limits:							
@ 50% Satisfied	2.4	2.8	1.9	2.3	2.9	2.0	2.4
@ 90% Satisfied	3.3	3.8	2.6	3.2	3.9	2.7	3.3

SPEED RANGE FOR OCTANE NUMBER REQUIREMENTS

SPEED RANGE	PR	FBRU	FBRSU
1599 and Lower	15	37	23
1600 - 1999	31	27	30
2000 - 2399	38	18	31
2400 - 2799	8	0	8
2800 - 3199	8	9	8
3200 and Higher	0	9	0

% Select Model Knocking on Tank Fuel = 0.0
Number of Test Vehicles = 15
Vehicles rated on Tank Fuel = 4

TABLE 14

OCTANE NUMBER REQUIREMENTS - 1990 SELECT MODELS

Select Model : F

Percent Satisfied	PR ON	FBRU RON	FBRU MON	FBRU (R+M)/2	FBRSU RON	FBRSU MON	FBRSU (R+M)/2
5	79.3	81.2	76.2	78.7	84.2	75.9	80.1
10	80.8	83.2	77.5	80.3	85.9	77.1	81.5
20	82.6	85.5	79.0	82.2	88.0	78.6	83.3
30	83.8	87.1	80.1	83.6	89.5	79.6	84.6
40	84.9	88.6	81.0	84.8	90.8	80.5	85.6
50	86.0	89.9	81.9	85.9	92.0	81.3	86.7
60	87.0	91.2	82.8	87.0	93.2	82.1	87.7
70	88.1	92.6	83.7	88.2	94.5	83.0	88.8
80	89.4	94.3	84.8	89.6	96.0	84.1	90.0
90	91.1	96.6	86.3	91.5	98.1	85.5	91.8
95	92.6	98.5	87.6	93.1	99.8	86.7	93.2
N	13	13	13	13	13	13	13
Mean	86.0	89.9	81.9	85.9	92.0	81.3	86.7
Estimated Std. Dev. of the Sample Population	4.0	5.3	3.5	4.4	4.7	3.3	4.0
t	2.18	2.18	2.18	2.18	2.18	2.18	2.18
95% Confidence Limits:							
@ 50% Satisfied	2.4	3.2	2.1	2.6	2.9	2.0	2.4
@ 90% Satisfied	3.4	4.4	2.9	3.6	3.9	2.7	3.3

SPEED RANGE FOR OCTANE NUMBER REQUIREMENTS

SPEED RANGE	PR	FBRU	FBRSU
1599 and Lower	9	0	0
1600 - 1999	9	18	9
2000 - 2399	55	37	64
2400 - 2799	18	36	18
2800 - 3199	9	9	9
3200 and Higher	0	0	0

% Select Model Knocking on Tank Fuel = 0.0
Number of Test Vehicles = 13
Vehicles rated on Tank Fuel = 1

TABLE 15

OCTANE NUMBER REQUIREMENTS - 1990 SELECT MODELS

Select Model : G

Percent Satisfied	PR ON	FBRU RON	FBRU MON	FBRU (R+M)/2	FBRSU RON	FBRSU MON	FBRSU (R+M)/2
5	77.3	80.7	75.9	78.3	80.3	73.4	76.9
10	78.9	82.0	76.8	79.4	81.9	74.5	78.2
20	80.9	83.6	77.8	80.7	83.7	75.7	79.7
30	82.3	84.8	78.6	81.7	85.1	76.6	80.8
40	83.6	85.8	79.2	82.5	86.2	77.4	81.8
50	84.7	86.7	79.8	83.3	87.3	78.1	82.7
60	85.8	87.6	80.4	84.0	88.4	78.8	83.6
70	87.0	88.6	81.1	84.8	89.5	79.6	84.6
80	88.5	89.8	81.8	85.8	90.9	80.5	85.7
90	90.5	91.4	82.9	87.1	92.8	81.8	87.3
95	92.1	92.7	83.7	88.2	94.3	82.8	88.5
N	13	13	13	13	13	13	13
Mean	84.7	86.7	79.8	83.3	87.3	78.1	82.7
Estimated Std. Dev. of the Sample Population	4.5	3.6	2.4	3.0	4.3	2.8	3.5
t	2.18	2.18	2.18	2.18	2.18	2.18	2.18
95% Confidence Limits:							
@ 50% Satisfied	2.7	2.2	1.4	1.8	2.6	1.7	2.1
@ 90% Satisfied	3.7	3.0	2.0	2.5	3.5	2.4	2.9

SPEED RANGE FOR OCTANE NUMBER REQUIREMENTS

SPEED RANGE	PR	FBRU	FBRSU
1599 and Lower	50	46	51
1600 - 1999	33	46	33
2000 - 2399	0	0	8
2400 - 2799	17	8	8
2800 - 3199	0	0	0
3200 and Higher	0	0	0

% Select Model Knocking on Tank Fuel = 0.0
Number of Test Vehicles = 13
Vehicles rated on Tank Fuel = 3

TABLE 16

OCTANE NUMBER REQUIREMENTS - 1990 SELECT MODELS

Select Model : H

Percent Satisfied	PR ON	FBRU RON	FBRU MON	FBRU (R+M)/2	FBRSU RON	FBRSU MON	FBRSU (R+M)/2
5	85.8	86.9	79.9	83.4	88.0	78.6	83.3
10	86.6	87.8	80.5	84.2	88.9	79.2	84.0
20	87.5	89.0	81.3	85.1	90.0	80.0	85.0
30	88.2	89.8	81.8	85.8	90.8	80.5	85.7
40	88.8	90.5	82.3	86.4	91.5	81.0	86.2
50	89.4	91.2	82.7	86.9	92.2	81.4	86.8
60	89.9	91.8	83.1	87.5	92.8	81.8	87.3
70	90.5	92.5	83.6	88.1	93.5	82.3	87.9
80	91.2	93.4	84.1	88.8	94.3	82.8	88.6
90	92.1	94.5	84.9	89.7	95.5	83.6	89.5
95	92.9	95.5	85.5	90.5	96.4	84.2	90.3
N	11	11	11	11	11	11	11
Mean	89.4	91.2	82.7	86.9	92.2	81.4	86.8
Estimated Std. Dev. of the Sample Population	2.2	2.6	1.7	2.1	2.6	1.7	2.1
t	2.23	2.23	2.23	2.23	2.23	2.23	2.23
95% Confidence Limits:							
@ 50% Satisfied	1.4	1.7	1.1	1.4	1.7	1.2	1.4
@ 90% Satisfied	2.0	2.4	1.6	2.0	2.4	1.6	2.0

SPEED RANGE FOR OCTANE NUMBER REQUIREMENTS

SPEED RANGE	PR	FBRU	FBRSU
1599 and Lower	9	19	9
1600 - 1999	0	0	9
2000 - 2399	55	37	37
2400 - 2799	9	18	18
2800 - 3199	18	18	9
3200 and Higher	9	9	18

% Select Model Knocking on Tank Fuel = 40.0
Number of Test Vehicles = 11
Vehicles rated on Tank Fuel = 5

TABLE 17

OCTANE NUMBER REQUIREMENTS - 1990 SELECT MODELS

Select Model : I

Percent Satisfied	PR ON	FBRU RON	FBRU MON	FBRU (R+M)/2	FBRSU RON	FBRSU MON	FBRSU (R+M)/2
5	74.2	77.4	73.4	75.4	77.1	71.2	74.1
10	75.9	78.8	74.4	76.6	78.8	72.4	75.6
20	77.9	80.5	75.6	78.1	81.0	73.8	77.4
30	79.3	81.8	76.4	79.1	82.6	74.9	78.7
40	80.5	82.8	77.2	80.0	83.9	75.8	79.8
50	81.6	83.8	77.8	80.8	85.1	76.6	80.9
60	82.8	84.8	78.5	81.6	86.4	77.5	81.9
70	84.0	85.8	79.2	82.5	87.7	78.4	83.0
80	85.4	87.1	80.1	83.6	89.3	79.4	84.3
90	87.4	88.8	81.2	85.0	91.4	80.9	86.2
95	89.0	90.2	82.2	86.2	93.2	82.1	87.6
N	15	15	15	15	15	15	15
Mean	81.6	83.8	77.8	80.8	85.1	76.6	80.9
Estimated Std. Dev. of the Sample Population	4.5	3.9	2.7	3.3	4.9	3.3	4.1
t	2.14	2.14	2.14	2.14	2.14	2.14	2.14
95% Confidence Limits:							
@ 50% Satisfied	2.5	2.2	1.5	1.8	2.7	1.8	2.3
@ 90% Satisfied	3.4	3.0	2.0	2.5	3.7	2.5	3.1

SPEED RANGE FOR OCTANE NUMBER REQUIREMENTS

SPEED RANGE	PR	FBRU	FBRSU
1599 and Lower	0	0	0
1600 - 1999	33	27	36
2000 - 2399	42	37	18
2400 - 2799	17	36	46
2800 - 3199	0	0	0
3200 and Higher	8	0	0

% Select Model Knocking on Tank Fuel = 20.0
Number of Test Vehicles = 15
Vehicles rated on Tank Fuel = 5

TABLE 18

OWNER/RATER COMPARISON OF TANK FUEL KNOCK

(1983-1990 CRC Octane Number Requirement Surveys)

Model Year:	1990	1989	1988	1987	1986	1985	1984	1983
Fuel:	Unleaded	Unleaded	Unleaded	Unleaded	Unleaded	Unleaded	Unleaded	Unleaded
Total Reports:	101	124	155	179	160	143	149	129
Percent Knocking								
Trained Rater	21.8	30.6	39.4	39.7	33.1	37.8	51.7	59.7
Owner	4.0	7.3	15.5	24.0	16.3	18.9	26.2	29.5
Owner/Rater Ratio	0.18	0.24	0.39	0.61	0.49	0.50	0.51	0.49
Percent Owners Objecting								
Based on:								
Total Reports	1.0	0.8	0.6	2.8	2.5	9.8	7.4	12.4
Owners Reporting Knock	25.0	11.1	4.2	11.6	15.4	51.9	28.2	42.1

TABLE 19

TANK-FUEL KNOCK REPORTED BY TRAINED OBSERVERS

Model Year	No. Survey	Total Vehicles Tested on Tank Fuel	
		No. Tested	% Knocking (Wtg. Avg.)
1990	356	103	18
1989	391	265	30
1988	391	293	31
1987	389	322	35
1986	377	330	31
1985	374	327	37
1984	407	358	49
1983	383	314	45

TABLE 20

ENGINE SPEEDS FOR OCTANE NUMBER REQUIREMENTS

Weighted % of Vehicles Having Requirements in Indicated (rpm) Ranges

All 1990 Vehicles

Engine Speed Range	PR Fuels	FBRU Fuels	FBRSU Fuels
1599 and Lower	14	15	13
1600 - 1999	17	18	16
2000 - 2399	30	19	19
2400 - 2799	18	25	27
2800 - 3199	15	15	12
3200 - 3599	5	4	7
3600 and Higher	1	4	6

TABLE 21

THROTTLE/GEAR POSITION FOR 1990

FBRU OCTANE NUMBER REQUIREMENTS

Throttle Position	Transmission Type & Gear		No. of Vehicles*	% of Vehicles
	Automatic Transmission			
Maximum	4-Speed:	4th	60	18
		3rd	54	16
		2nd	38	11
	3-Speed:	3rd	56	17
		2nd	22	7
Part	4-Speed:	4th	23	7
		3rd	15	4
		2nd	0	0
	3-Speed	3rd	21	6
		2nd	4	1
	Manual Transmission			
Maximum	5-Speed:	4th	17	5
		3rd	10	3
	4-Speed:	3rd	1	0
Part	6-Speed:	4th	1	0
	5-Speed:	4th	10	3
		3rd	2	1
	4-Speed:	4th	1	0

* Sixteen test vehicles not counted, because all FBRU fuels satisfied their octane number requirements. One missing value for gear position.

Figure 1

DISTRIBUTION OF ODOMETER MILEAGE FOR 1990 MODEL VEHICLES TESTED

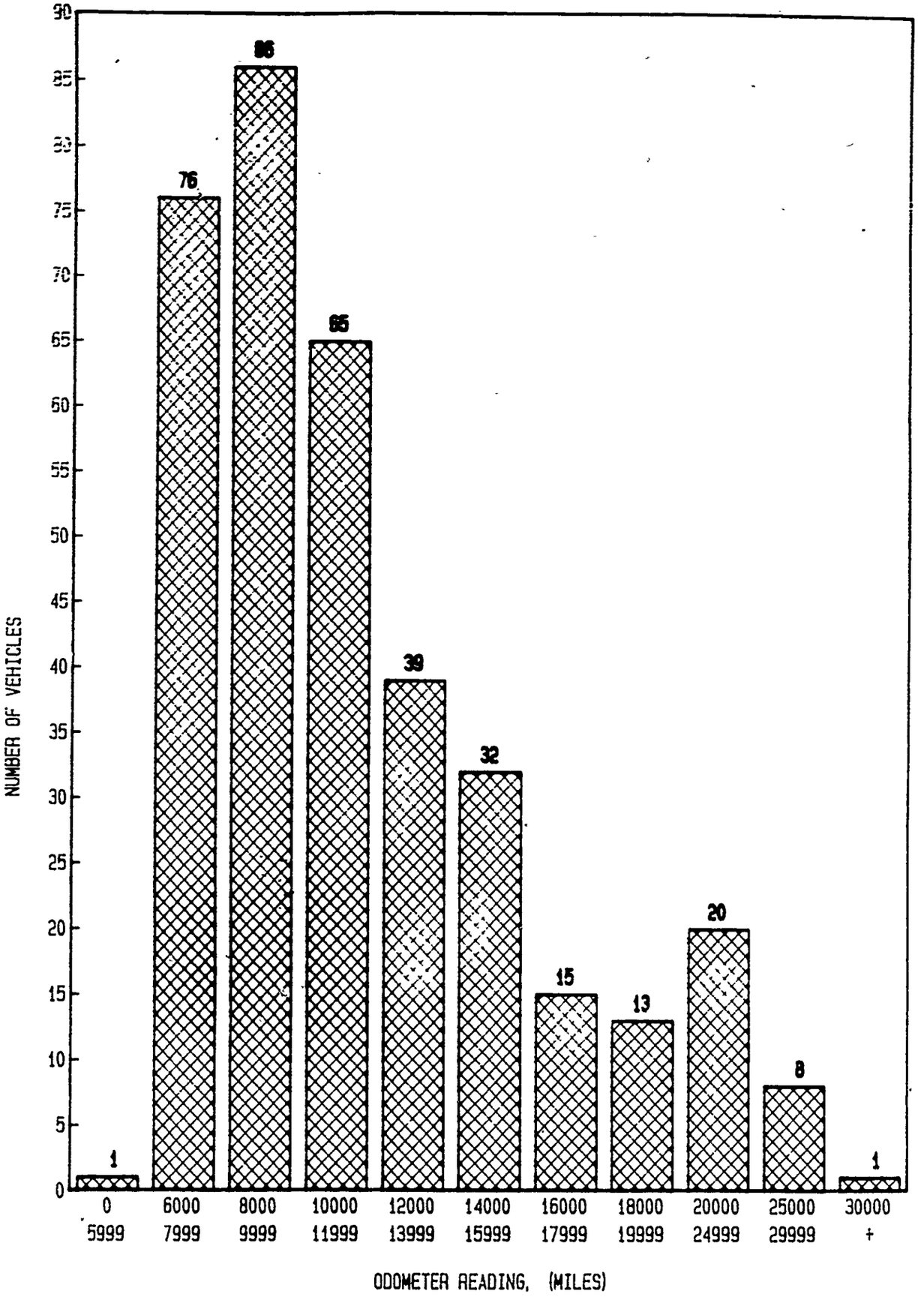


Figure 2

DISTRIBUTION OF MAXIMUM PR FUEL (R+M)/2 OCTANE NUMBER REQUIREMENTS

1990 TOTAL VEHICLES

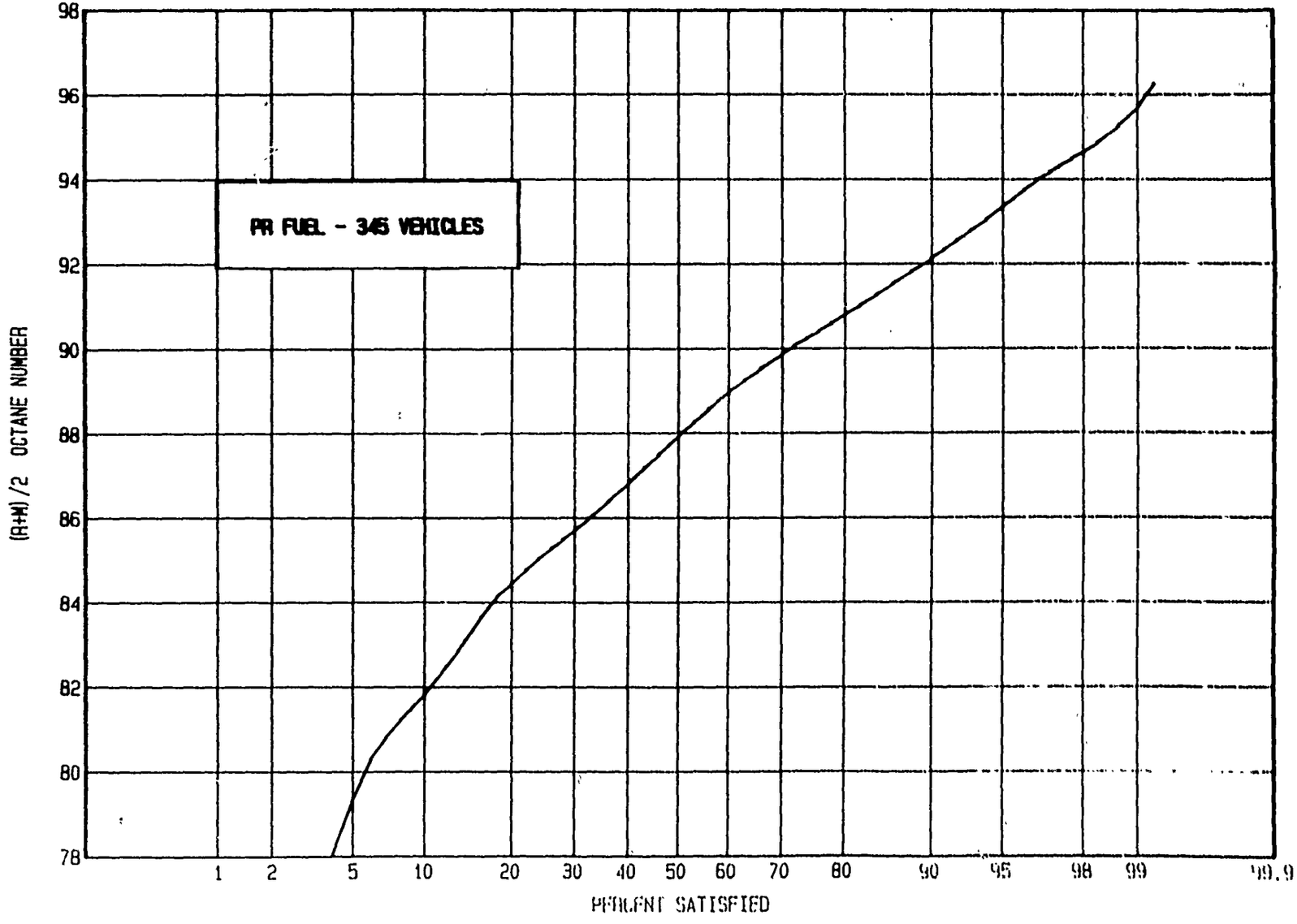


Figure 3
DISTRIBUTION OF MAXIMUM FBRU FUEL (R+M)/2 OCTANE NUMBER REQUIREMENTS
1990 TOTAL VEHICLES

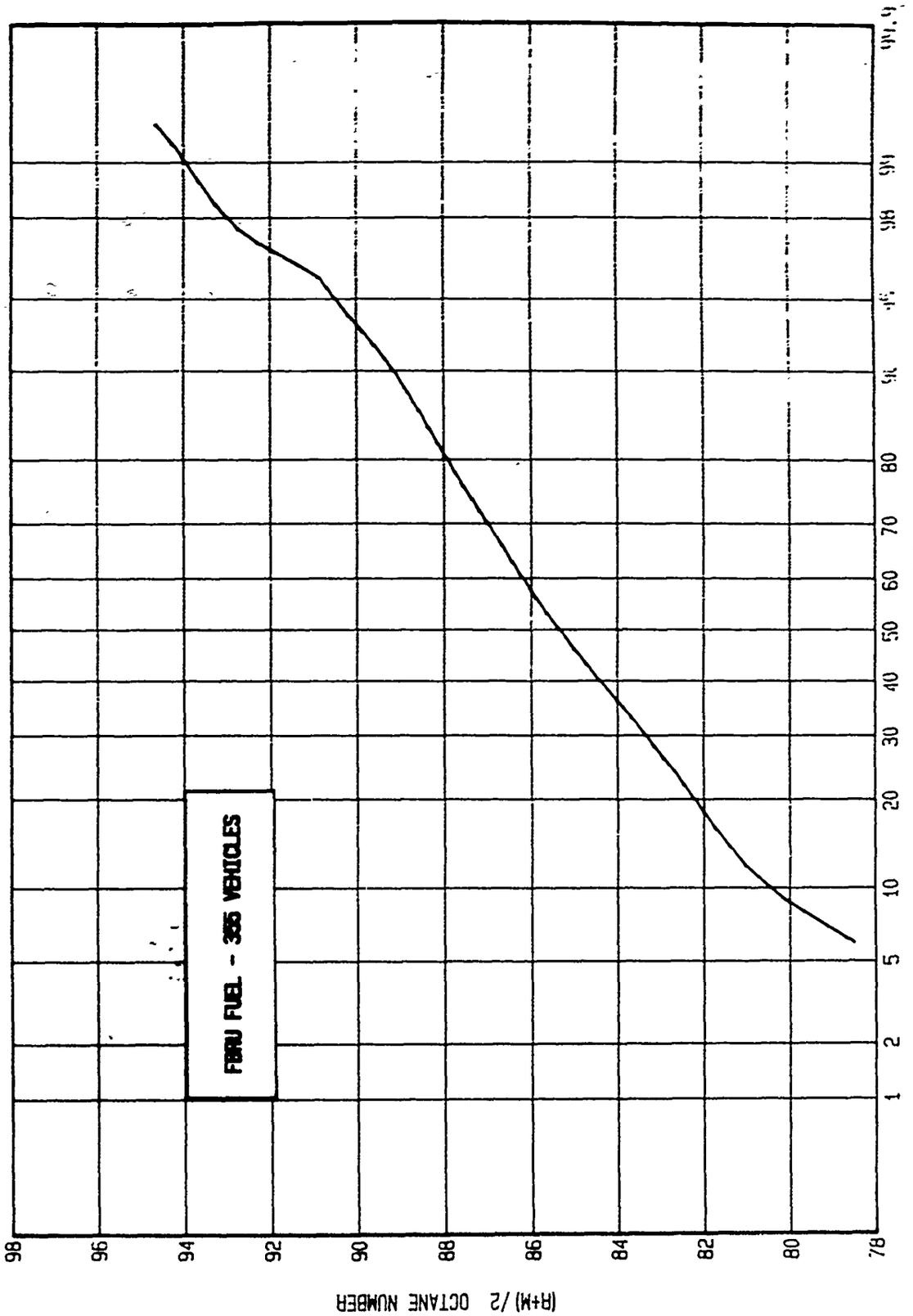


Figure 4

DISTRIBUTION OF MAXIMUM FBRSU FUEL (R+M)/2 OCTANE NUMBER REQUIREMENTS

1990 TOTAL VEHICLES

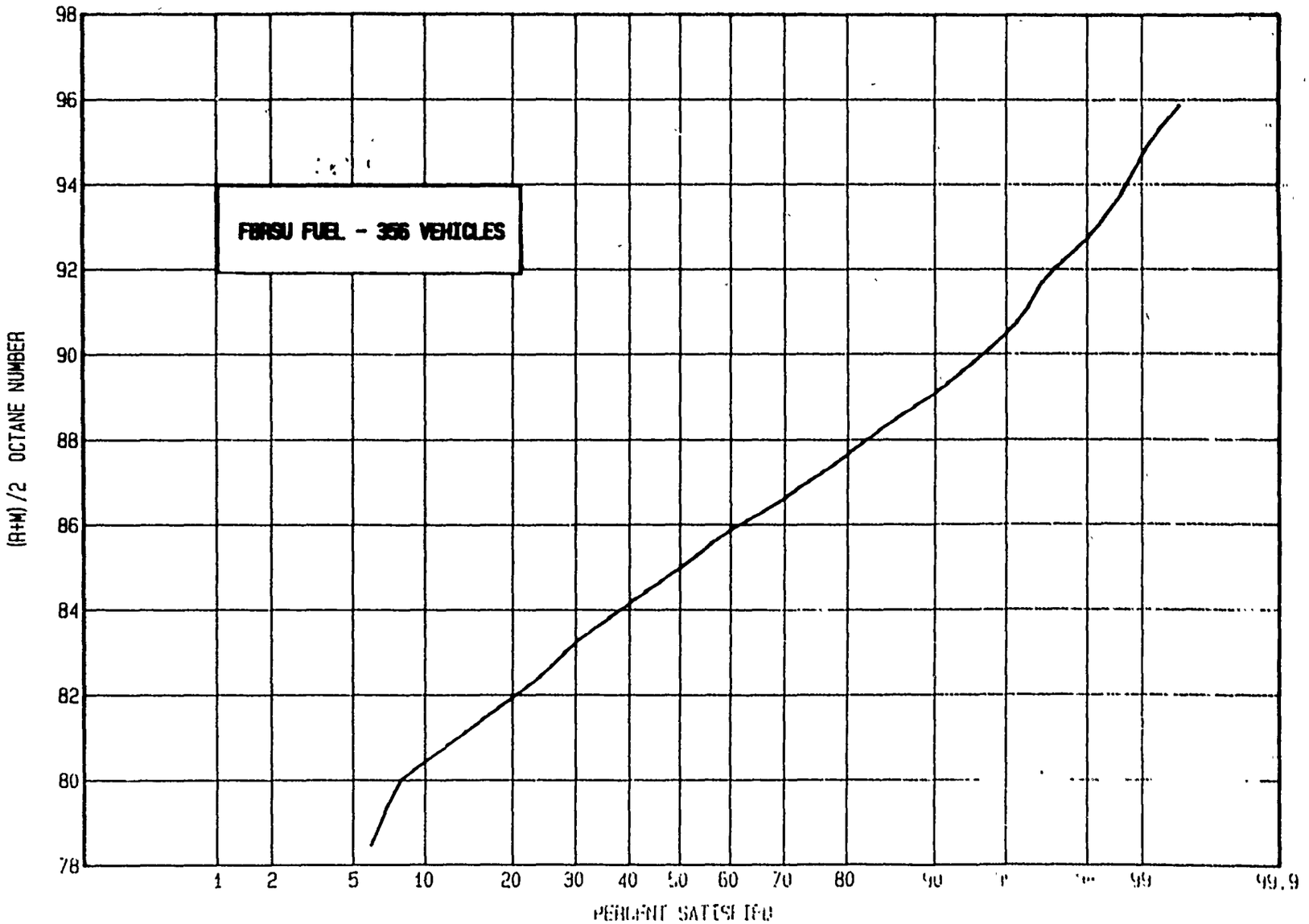


Figure 5
DISTRIBUTION OF MAXIMUM (R+M)/2 OCTANE NUMBER REQUIREMENTS
1990 TOTAL VEHICLES

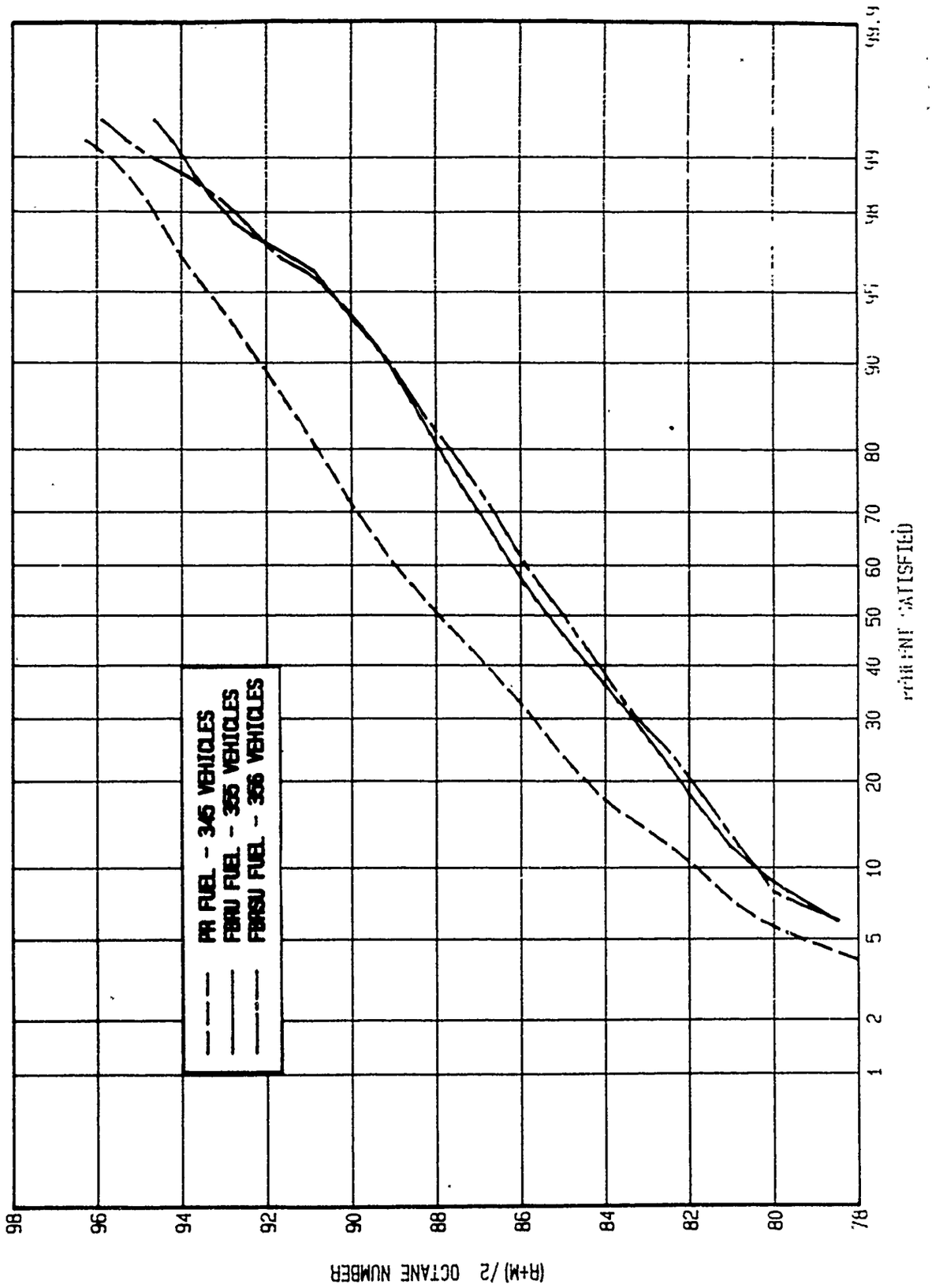


Figure 6
DISTRIBUTION OF MAXIMUM FBRU FUEL (R+M)/2 OCTANE NUMBER REQUIREMENTS
1990 AND 1989 TOTAL VEHICLES

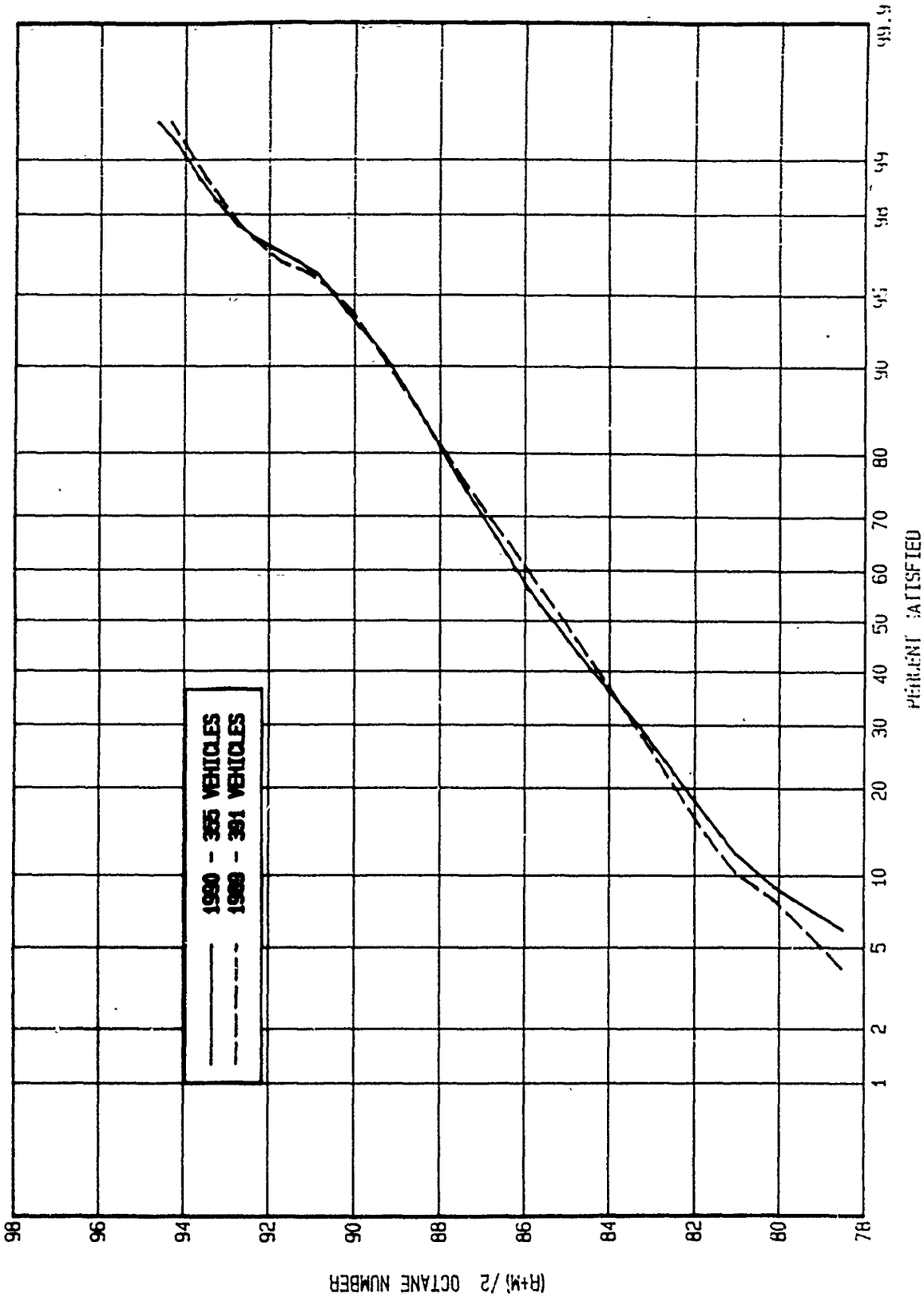


Figure 7
DISTRIBUTION OF MAXIMUM (R+M)/2 OCTANE NUMBER REQUIREMENTS
1990 TOTAL CARS

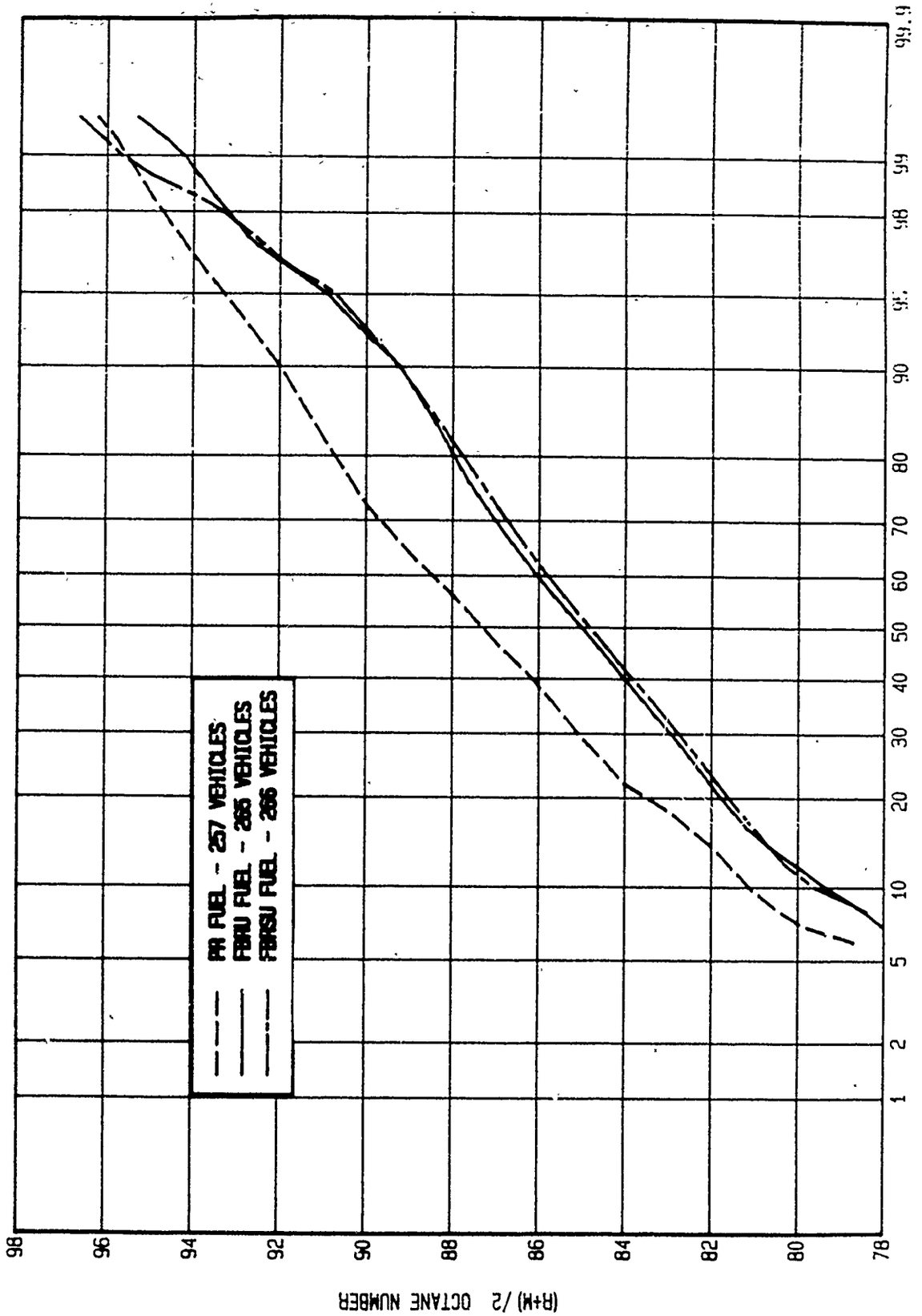


Figure 8
DISTRIBUTION OF MAXIMUM FBRU FUEL (R+M)/2 OCTANE NUMBER REQUIREMENTS
1990 AND 1989 TOTAL CARS

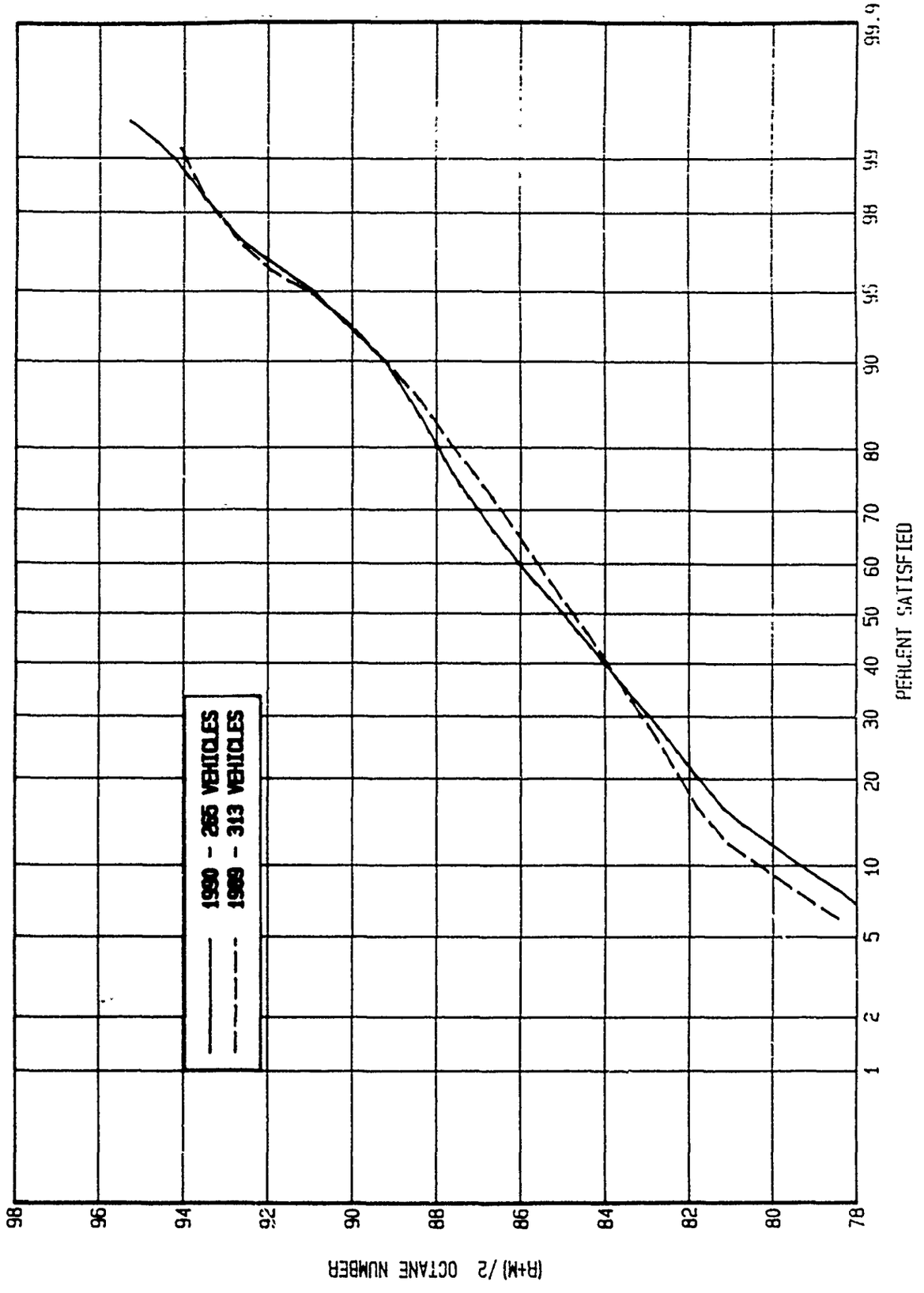


Figure 9
DISTRIBUTION OF MAXIMUM (R+M)/2 OCTANE NUMBER REQUIREMENTS
1990 TOTAL TRUCKS AND VANS

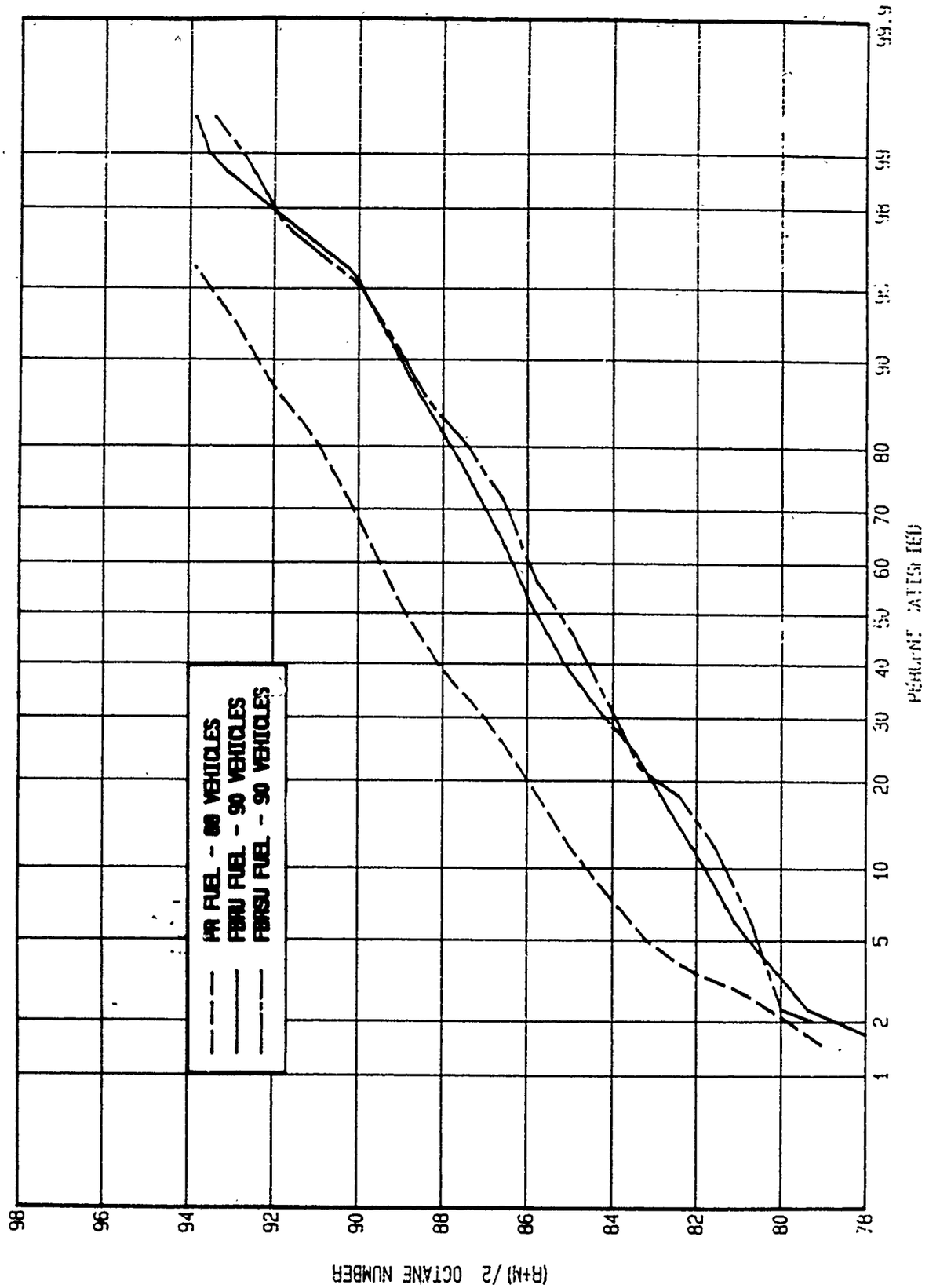


Figure 10

DISTRIBUTION OF MAXIMUM FBRU FUEL (R+M)/2 OCTANE NUMBER REQUIREMENTS

1990 AND 1989 TOTAL TRUCKS AND VANS

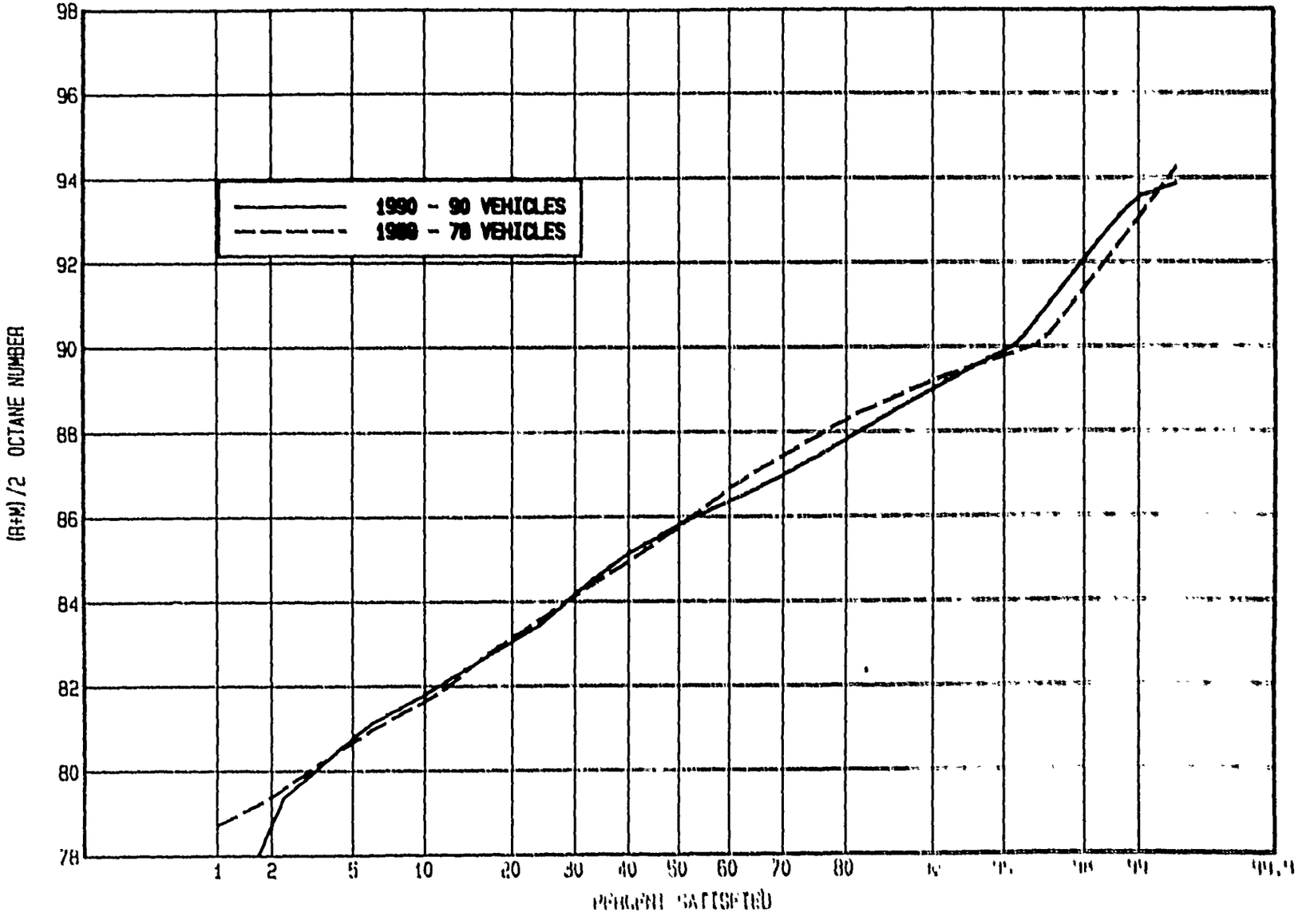


Figure 11
DISTRIBUTION OF MAXIMUM (R+M)/2 OCTANE NUMBER REQUIREMENTS
1990 KNOCK SENSOR VEHICLES

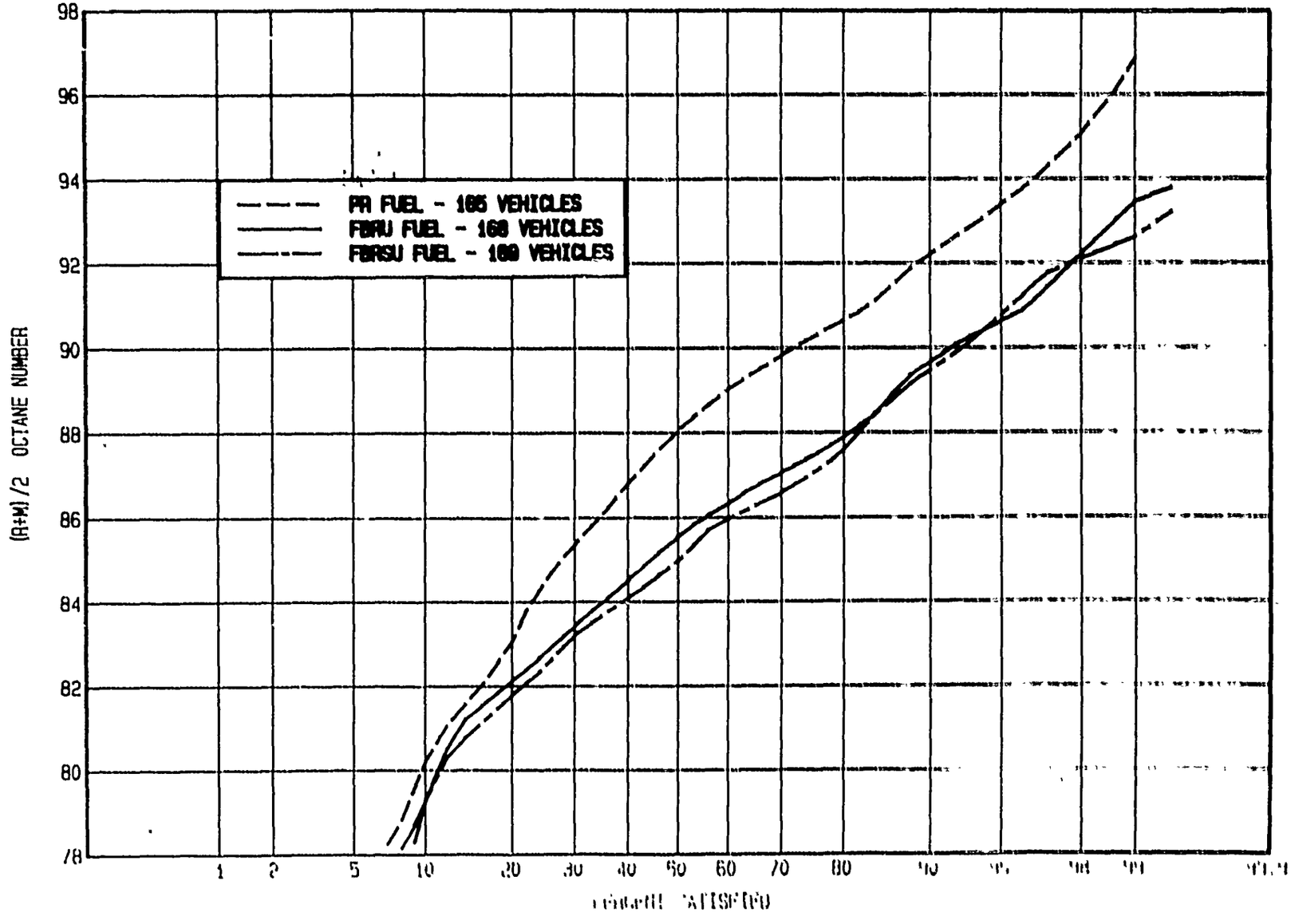
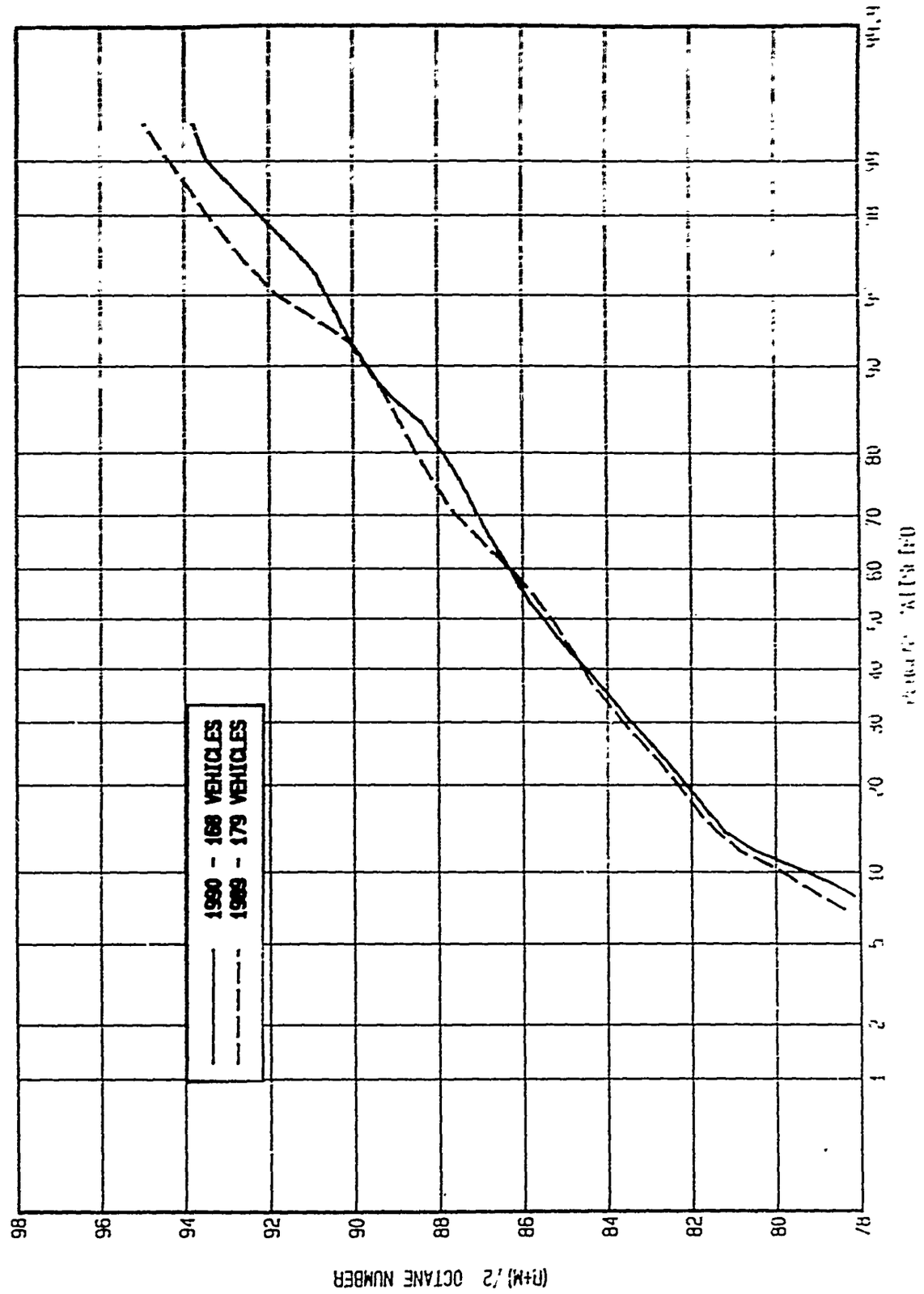


Figure 12
DISTRIBUTION OF MAXIMUM FBRU FUEL (R+M)/2 OCTANE NUMBER REQUIREMENTS
1990 AND 1989 KNOCK SENSOR VEHICLES



A P P E N D I X A

PARTICIPATING LABORATORIES

PARTICIPATING LABORATORIES

No. of Vehicles Tested	Eastern Area	East Central Area	No. of Vehicles Tested
26	Exxon Res. & Engrg. Co. Linden, NJ	Ashland Oil Ashland, KY	4
30	Mobil Res. & Dev. Corp. Paulsboro, NJ	BP Oil Company Cleveland, OH	30
20	Sun Company Marcus Hook, PA	Ford Motor Company Dearborn, MI	10
30	Texaco Inc. Beacon, NY	Nissan Res. & Dev. Ann Arbor, MI	6
		Petro-Canada Products Sheridan Park, Ontario	29
		Shell Canada Oakville, Ontario	15
		Toyota Motor Corp. Ann Arbor, MI	5

	Western Area	West Central Area	
30	Chevron Res. & Technology Co. Richmond, CA	Chrysler Corporation Detroit, MI	10
29	Unocal Corporation Brea, CA	Amoco Oil Company Naperville, IL	31
		Phillips Petroleum Co. Bartlesville, OK	21
		Shell Development Co. Houston, TX	30

APPENDIX B

MEMBERSHIP: 1990 ANALYSIS PANEL

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

1990 ANALYSIS PANEL

Name	Company
D. I. Hoel, Leader	Exxon Research and Engineering Company
W. F. Biller	Consultant
C. J. Bones	Mobil Research and Development Corporation
J. C. Callison	Amoco Oil Company
J. P. Graham	Chevron Research and Technology Company
J. P. Uihlein	BP Oil Company
T. Wusz	Unocal Corporation

APPENDIX C

DATA ON 1989/1990

FULL-BOILING RANGE REFERENCE FUELS

TABLE C-1

SUPPLIERS' FUEL INSPECTIONS

1989/1990 FBRU FUELS

	Low-Octane Base Blend RMFD 368-89/90	Intermediate-Octane Base Blend RMFD 369-89/90	High-Octane Base Blend RMFD 370-89/90
Laboratory Inspection			
Distillation, °F			
IBP	91	90	90
10% Evap.	136	118	127
30% Evap.	176	152	182
50% Evap.	209	196	218
70% Evap.	233	250	248
90% Evap.	325	334	286
End Point	426	425	357
RVP, psi	7.1	8.3	7.5
Lead, g/gal.	0.000	0.000	0.000
Oxidation Stab., min.	1440+	1440+	1440+
Hydrocarbon Type, Vol. %			
Aromatics	19.6	25.7	46.4
Olefins	10.0	15.0	3.2
Saturates	70.4	59.3	50.4
Research Octane Number	79.3	90.6	104.2
Motor Octane Number	74.5	82.2	92.7
Sensitivity	4.8	8.4	11.5

TABLE C-2

OCTANE NUMBERS AND COMPOSITIONS FOR 1989/1990 FBRU FUELS

Research Octane Number	Volume Percent RMFD 368-89/90	RMFD 369-89/90	RMFD 370-89/90	Motor Octane Number	Sensitivity
80	91.5	8.5	---	75.2	4.8
82	75.0	25.0	---	76.7	5.3
84	59.0	41.0	---	78.1	5.9
85	51.0	49.0	---	78.7	6.3
86	42.5	57.5	---	79.4	6.6
87	34.0	66.0	---	80.0	7.0
88	25.0	75.0	---	80.7	7.3
89	15.5	84.5	---	81.3	7.7
90	5.0	95.0	---	81.9	8.1
91	---	96.5	3.5	82.6	8.4
92	---	90.0	10.0	83.3	8.7
93	---	83.5	16.5	83.9	9.1
94	---	76.5	23.5	84.5	9.5
95	---	69.5	30.5	85.2	9.8
96	---	62.5	37.5	85.9	10.1
97	---	55.0	45.0	86.6	10.4
98	---	48.0	52.0	87.3	10.7
99	---	40.5	59.5	88.0	11.0
100	---	32.5	67.5	88.8	11.2
101	---	24.0	76.0	89.6	11.4
102	---	16.0	84.0	90.4	11.6
103	---	8.0	92.0	91.4	11.6
104	---	0.0	100.0	92.6	11.4

TABLE C-3

SUPPLIERS' FUEL INSPECTIONS

1989/1990 FBRSU FUELS

	Low-Octane Base Blend RMFD 371-89/90	Intermediate-Octane Base Blend RMFD 372-89/90	High-Octane Base Blend RMFD 373-89/90
Laboratory Inspection			
Distillation, °F			
IBP	90	97	91
10% Evap.	135	127	137
30% Evap.	174	158	190
50% Evap.	207	206	232
70% Evap.	247	280	256
90% Evap.	365	369	312
End Point	431	430	402
RVP, psi	8.1	7.1	7.5
Lead, g/gal.	0.000	0.000	0.000
Oxidation Stab., min.	1440+	1440+	1440+
Hydrocarbon Type, Vol. %			
Aromatics	23.7	31.5	50.4
Olefins	29.9	21.5	3.8
Saturates	46.4	47.0	45.8
Research Octane Number	79.5	91.6	104.0
Motor Octane Number	72.9	81.2	90.5
Sensitivity	6.6	10.4	13.5

TABLE C-4

OCTANE NUMBERS AND COMPOSITIONS FOR 1989/1990 FBRSU FUELS

Research Octane Number	Volume Percent RMFD 371-89/90	RMFD 372-89/90	RMFD 373-89/90	Motor Octane Number	Sensitivity
80	96.5	3.5	---	73.1	6.9
82	80.5	19.5	---	74.6	7.4
84	65.5	34.5	---	75.9	8.1
85	58.0	42.0	---	76.5	8.5
86	49.5	50.5	---	77.2	8.8
87	41.0	59.0	---	77.9	9.1
88	32.5	67.5	---	78.6	9.4
89	24.5	75.5	---	78.3	9.7
90	15.5	84.5	---	80.0	10.0
91	6.5	93.5	---	80.6	10.4
92	---	98.0	2.0	81.2	10.8
93	---	90.5	9.5	81.9	11.1
94	---	83.5	16.5	82.6	11.4
95	---	75.5	24.5	83.3	11.7
96	---	67.5	32.5	84.0	12.0
97	---	59.5	40.5	84.7	12.3
98	---	51.0	49.0	85.5	12.5
99	---	42.5	57.5	86.3	12.7
100	---	34.0	66.0	87.1	12.9
101	---	25.0	75.0	87.9	13.1
102	---	15.5	84.5	88.8	13.2
103	---	5.0	95.0	89.8	13.2
103.5	---	0.0	100.0	90.3	13.2

APPENDIX D

PROGRAM

COORDINATING RESEARCH COUNCIL
INCORPORATED
219 PERIMETER CENTER PARKWAY
ATLANTA, GEORGIA 30346
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Not to be Published

PROGRAM

for the

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

CRC Project No. CM-123-90

June 1990

TABLE OF CONTENTS

I. INTRODUCTION

The 1990 program of the CRC Light-Duty Octane Number Requirement Survey Group will consist of a survey of the octane number requirements of 1990 model domestic and imported vehicles. For the purposes of this program, the designation "passenger vehicles" will include passenger cars, light-duty (<8500 lb/3856 kg GVW) pickup trucks, and vans. Approximately 450 vehicles will be tested. Most of these vehicles will be sampled in proportion to their relative production or import volume, to provide data from which to estimate the distribution of octane number requirements for the 1990 model vehicle population in the United States. In addition, select models of special interest will be tested in sufficient numbers to estimate their requirement distributions.

Knocking characteristics will be investigated with three series of reference fuels. Tank fuel knock will also be evaluated. Maximum octane number requirements, whether at maximum-throttle or part-throttle, will be established for each vehicle using high sensitivity unleaded full-boiling range reference (FBRSU) fuels, average sensitivity unleaded full-boiling range reference (FBRU) fuels, and primary reference (PR) fuels. If the maximum requirement is at maximum-throttle, then part-throttle requirements are investigated with only FBRU fuels of up to, and including, four octane numbers lower than the maximum requirement

II. GEOGRAPHICAL AREAS

As in previous years, the 1990 Survey will be conducted on a nationwide basis for the US, and will include Canada. Four geographical areas have been established for test vehicle assignment purposes. Participants located in New York, New Jersey, and Pennsylvania are included in the Eastern Area; those located in Ohio, Michigan, and Kentucky comprise the East Central Area; those in Illinois, Texas, and Oklahoma comprise the West Central Area; and California participants make up the Western Area. Canadian participants are assigned to either the East or West Central Areas. Coordinators for each of the areas are as follows:

Eastern Area.....D. I. Hoel
East Central Area.....J. P. Uihlein
West Central Area.....J. B. Baker
Western Area.....T. Wusz

The area coordinators will contact their area participants periodically regarding the progress of the survey. To expedite this, it is suggested that participants send copies of all correspondence concerning the survey to the area coordinators. This program outlines the survey in broad terms. If more detailed information is desired, it is suggested that the participant contact his area coordinator.

III. VEHICLES

A total of approximately 450 vehicles will be tested in the 1990 Survey. Current experience indicates we can expect about 14 full participants and 5 partial participants. The 450 vehicle total will be divided into two groups: (1) the statistical group, sampled in proportion to US car model production or import volume, and (2) select models of special interest. Approximately 20 of each of these select models are assigned to be tested in order to provide an estimate of the octane requirement distribution of each model. Some of these 20 vehicles will be those already included in the statistical group, and the remainder will be additional vehicles added to the program.

The desired number of vehicles to be tested in each category is as follows:

Statistical Group	390
Additional Select Model Group	60
Total	450

A detailed breakdown of the specific models and the number of each model to be tested will be circulated to the participants after an estimate of vehicle model production has been obtained. Design specifications for select models to be tested in the 1990 Survey are shown in Table D-I. Selection of these vehicles has been based on new or modified design characteristics that might have a significant effect on octane number requirements and high sales volume which allows individual treatment without additional testing.

Wherever possible, specific vehicle assignments to individual participating laboratories will be made in a pattern which tends to minimize data bias. This will be accomplished by apportioning cars of a given model among the four geographical areas, and subsequently among the laboratories within each area, in order to minimize the effect of non-random factors on the results of the Survey.

IV. FUELS

A. Full-Boiling Range Reference Fuels

Two full-boiling range reference fuel series will be used to define the vehicle octane number requirements. The two series will be unleaded and of varying sensitivity. One series will be comparable to the average sensitivity of unleaded commercial fuels (FBRU); the other series (FBRSU) will be a minimum of two numbers higher in sensitivity than the FBRU fuels. The Research octane number (RON) range for both fuel series is 79 to 104.

These fuels will be blended in increments of two RON up to 84, and one RON above 84 from three base fuels for each series. The base fuels are compounded from normal refinery gasoline components. Limiting specifications for each base fuel for both series are shown in Table D-II. Supplier inspection data are shown in Table D-III.

Research and Motor ratings will be determined for incremental blends of each fuel series by participants to provide data for establishment of blending curves. The average ratings and blending curves appear in Tables D-IV and D-V.

B. Primary Reference Fuels

Blends of ASTM-grade isooctane and normal heptane will be prepared in two octane number increments from 76 to 82, and one octane number increments from 82 to 100.

C. Tank Gasoline

Research and Motor octane ratings will be obtained only on gasoline samples from the tank of vehicles with owner questionnaire (Attachment 1). Owner's Questionnaire should be obtained if:

a) vehicle has a regular driver; and

b) the ignition timing is within $\pm$ 2^{o} of the manufacturer's specifications.

V. TEST TECHNIQUE

All tests are to be conducted using the technique entitled, "Technique for Determination of Octane Number Requirements of Light-Duty Vehicles" (CRC Designation E-15-90). A copy of this technique is included as Attachment 2 to this program. Octane number requirement investigations are to be conducted in all vehicles under level road conditions. Any vehicle obviously in poor mechanical condition or with malfunctioning emission control devices should not be considered for test work. The vehicles must have a minimum of 6000 deposit miles (9656 km), and preferably be privately owned and operated. Data with less than 6000 miles will not be analyzed. Vehicles previously used for fuel road octane rating must not be employed in this survey.

Data should be reported on each vehicle tested, even though knock was not encountered on any of the fuels.

The order in which the fuels are to be tested is as follows:

1) Tank fuel;
2) FBRSU;
3) FBRU;
4) PR.

VI. DATA FORMS

The test results on each vehicle will be reported on Data Form ONRS-90. Copies of these forms will be mailed to all participants from the CRC office with instructions for their use. Additional instructions are included in the E-15-90 technique.

VII. REPORTING RESULTS

The original data forms for each vehicle tested should be submitted to William F. Biller, 68 Yorktown Road, East Brunswick, New Jersey 08816, as soon as possible, but not later than October 31, 1990.

TABLE D-I

DESIGN SPECIFICATIONS FOR 1990 SELECT MODELS

Make & Model	Engine Displ. Liters	Configuration & No. of Cylinders	Fuel System	Comp. Ratio	BHP	Knock-Sensor	VIN Engine Code	Trans. Type
GM								
Pontiac Grandam/ Oldsmobile Calais/ Chevrolet Beretta	2.3 (High Output)	L-4	PFI	10.0	180	Yes	A	M-5
Chrysler								
Plymouth Acclaim/ Dodge Spirit/ Plymouth Voyager/ Dodge Caravan/ Dodge Daytona/ Dodge Dynasty/ Chrylser LeBaron/ Chrysler TC by Maserati	3.0	V-6	PFI	8.9	142	No	3	A-4
Plymouth Grand Voyager/ Dodge Grand Caravan/ Dodge Dynasty/ Chrysler New Yorker/ Chrysler Fifth Avenue/ Chrysler Town & Country	3.3	V-6	PFI	8.9	150	Yes	R	A-4

TABLE D-II

LIMITING SPECIFICATIONS FOR 1989 AND 1990 FULL-BOILING RANGE REFERENCE FUELS*

Inspection Tests	Unleaded Average Sensitivity Reference Fuels (FBRU)			Unleaded High Sensitivity Reference Fuels (FBRSU)		
	RMFD 368		RMFD 369	RMFD 370	RMFD 371	RMFD 372	RMFD 373
ASTM Distillation, °F(°C)							
IBP, Min.	90	(32.2)	90	90	90	90	90
10% Evap.	115-158	(46.1- 70.0)	115-158	115-158	115-158	115-158	115-158
30% Evap.	150-190	(65.6- 87.8)	150-190	150-190	150-190	150-190	150-190
50% Evap.	195-250	(90.6-121.1)	195-250	195-250	195-250	195-250	195-250
70% Evap.	230-300	(110.0-148.9)	230-300	230-300	230-300	230-300	230-300
90% Evap.	285-374	(140.6-190.0)	285-374	285-374	285-374	285-374	285-374
End Point, Max.	437	(225)	437	437	437	437	437
RVP, psi (KPa)	7-9	(48-62)	7-9	7-9	7-9	7-9	7-9
Lead, g/gal (g/l)	<0.03	(<0.008)	<0.03	<0.03	<0.03	<0.03	<0.03
Oxidation Stability, Minutes, Min.	1440		1440	1440	1440	1440	1440
Hydrocarbon Type, Vol. %							
Aromatics, Max.**	20		35	55	35	45	65
Olefins, Max.	20		15	10	35	25	15
Saturates	Remainder		Remainder	Remainder	Remainder	Remainder	Remainder
Octane Number							
Research	79 ± 1		91 ± 1	104 ± 1	79 ± 1	91 ± 1	104 ± 1
Sensitivity***	4.5 ± .5		8.5 ± .5	11.5 ± .5	6.5 ± .5	10.5 ± .5	13.5 ± .5
Minimum of two units sensitivity difference between corresponding fuels of each series.							
Color	Bronze		Green	Red	Yellow	Deep Purple	Light Blue

Note: All fuels to contain minimum 5 PTB of a 100% active antioxidant and 10 PTB of corrosion inhibitor. No manganese added.

Confirmation of product quality of fuel blends to be approved by a six-laboratory CRC Fuel Acceptance Panel prior to drumming.

TABLE D-III

SUPPLIER INSPECTION DATA FOR 1989 AND 1990 FULL-BOILING RANGE REFERENCE FUELS

Inspection Tests	Unleaded Average Sensitivity Reference Fuels (FBRU)			Unleaded High Sensitivity Reference Fuels (FBRSU)		
	RMFD 368	RMFD 369	RMFD 370	RMFD 371	RMFD 372	RMFD 373
ASTM Distillation, °F						
IBP	91	90	90	90	97	91
10% Evap.	136	118	127	135	127	137
30% Evap.	176	152	182	174	158	190
50% Evap.	209	196	218	207	206	232
70% Evap.	233	250	248	247	280	256
90% Evap.	325	334	286	365	369	312
Endpoint	426	425	357	431	430	402
RVP, psi	7.1	8.3	7.5	8.1	7.1	7.5
Lead, g/gal	0.000	0.000	0.000	0.000	0.000	0.000
Oxidation Stability, Minutes	1440+	1440+	1440+	1440+	1440+	1440+
Hydrocarbon Type, Vol. %						
Aromatics	19.6	25.7	46.4	23.7	31.5	50.4
Olefins	10.0	15.0	3.2	29.9	21.5	3.8
Saturates	70.4	59.3	50.4	46.4	47.0	45.8
Octane Number						
Research	79.3	90.6	104.2	79.5	91.6	104.0
Sensitivity	4.8	8.4	11.5	6.6	10.4	13.5

TABLE D-IV

COMPOSITIONS AND OCTANE NUMBERS

FOR CRC 1989-90 FBRU REFERENCE FUELS

Research Octane Number	Volume Percent RMFD 368-89	RMFD 369-89	RMFD 370-89	Motor Octane Number	Sensitivity
80	91.5	8.5	--	75.2	4.8
82	75.0	25.0	--	76.7	5.3
84	59.0	41.0	--	78.1	5.9
85	51.0	49.0	--	78.7	6.3
86	42.5	57.5	--	79.4	6.6
87	34.0	66.0	--	80.0	7.0
88	25.0	75.0	--	80.7	7.3
89	15.5	84.5	--	81.3	7.7
90	5.0	95.0	--	81.9	8.1
91	--	96.5	3.5	82.6	8.4
92	--	90.0	10.0	83.3	8.7
93	--	83.5	16.5	83.9	9.1
94	--	76.5	23.5	84.5	9.5
95	--	69.5	30.5	85.2	9.8
96	--	62.5	37.5	85.9	10.1
97	--	55.0	45.0	86.6	10.4
98	--	48.0	52.0	87.3	10.7
99	--	40.5	59.5	88.0	11.0
100	--	32.5	67.5	88.8	11.2
101	--	24.0	76.0	89.6	11.4
102	--	16.0	84.0	90.4	11.6
103	--	8.0	92.0	91.4	11.6
104	--	0.0	100.0	92.6	11.4

TABLE D-V

COMPOSITIONS AND OCTANE NUMBERS

FOR CRC 1989-90 FBRSU REFERENCE FUELS

Research Octane Number	Volume Percent RMFD 371-89	RMFD 372-89	RMFD 373-89	Motor Octane Number	Sensitivity
80	96.5	3.5	--	73.1	6.9
82	80.5	19.5	--	74.6	7.4
84	65.5	34.5	--	75.9	8.1
85	58.0	42.0	--	76.5	8.5
86	49.5	50.5	--	77.2	8.8
87	41.0	59.0	--	77.9	9.1
88	32.5	67.5	--	78.6	9.4
89	24.5	75.5	--	79.3	9.7
90	15.5	84.5	--	80.0	10.0
91	6.5	93.5	--	80.6	10.4
92	--	98.0	2.0	81.2	10.8
93	--	90.5	9.5	81.9	11.1
94	--	83.5	16.5	82.6	11.4
95	--	75.5	24.5	83.3	11.7
96	--	67.5	32.5	84.0	12.0
97	--	59.5	40.5	84.7	12.3
98	--	51.0	49.0	85.5	12.5
99	--	42.5	57.5	86.3	12.7
100	--	34.0	66.0	87.1	12.9
101	--	25.0	75.0	87.9	13.1
102	--	15.5	84.5	88.8	13.2
103	--	5.0	95.0	89.8	13.2
103.5	--	0.0	100.0	90.3	13.2

Attachment 1

CRC OCTANE NUMBER REQUIREMENT SURVEY

OWNER'S QUESTIONNAIRE

OWNER:

Your vehicle is being tested for fuel octane number requirements by a Coordinating Research Council activity. To help analyze the data, we would like the person who has recently been driving the vehicle to answer the following questions:

1. What grade of unleaded fuel was purchased the last two times?

☐ Regular ☐ Mid-Grade ☐ Premium

2. Has any engine knock (ping) been encountered with the fuel that is now in the tank?

☐ Yes ☐ No

3. Did you consider the knock (ping) objectionable?

☐ Yes ☐ No

Vehicle Make _____ License No. _____

Vehicle Identification No. _____

Company Testing Vehicle _____

Attachment 2

TECHNIQUE FOR DETERMINATION OF OCTANE NUMBER REQUIREMENTS OF LIGHT-DUTY VEHICLES

(CRC Designation E-15-90)

June 1990

I. OBJECTIVE

This procedure establishes the octane number requirements of light-duty vehicles, under defined test conditions. Testing will be conducted with a series of reference fuels using full-throttle and part throttle accelerations and transient-throttle maneuvers.

II. OVERVIEW OF TEST PROCEDURE

A. Test Procedure

The first step in octane rating is to determine the transmission characteristics of the vehicle. This information tells the driver what engine speed and manifold vacuum is used to obtain the engine conditions needed to measure octane requirement. The transmission characteristic information is not part of the octane requirement data, but is obtained as an aid to the driver.

The maximum octane requirement of the vehicle is the highest octane number fuel in a fuel series which causes borderline knock in at least one engine condition. When the highest knocking fuel causes above-borderline knock, the maximum octane requirement is intermediate between that fuel and the next highest non-knocking fuel. A maximum octane requirement is determined on each of the fuel series. The part-throttle requirement on the FBRU fuel series is investigated and reported in the octane number interval up to four numbers less than the wide-open-throttle requirement.

B. Data Forms

Data Form ONRS-MY* consists of four sides: A, B, C, D. Side A includes company information, vehicle data, weather data, knock data on tank fuel, and the octane number requirement summary. Completion of the octane number requirement summary is discussed in Section IX. Side B has a table for transmission characteristic information. This information is located for convenient reference during the octane rating procedure. Side B also has a check list of items to be used during vehicle preparation. Side C is used during the octane rating procedure to record the data from all accelerations, whether they give knock or not.

*MY = current model year

Side D continues the data from side C. It also contains footnote references for the entire form and space for any comments the rater wishes to make. If the rating procedure requires more space for data than is provided in sides C and D, additional C and D sides should be used.

A completed Owner's Questionnaire Form ONRS-MY, Side E should be obtained if the vehicle has a regular driver and the engine spark timing has not been adjusted for testing.

III. TEST PREPARATION

The vehicle must be prepared to operate as the manufacturer intended, but with an auxiliary fuel system. Care should be exercised when preparing the vehicle for testing to ensure that the test reflects normal operating conditions.

A. Vehicle Inspection

Vehicles should be inspected to ensure that engine operation is correct. A list of required items to check is included on ONRS-MY, Side B. This list is a guide only. Individual laboratories may choose to check additional vehicle characteristics.

B. Test Equipment Installation

A calibrated tachometer graduated in 100 rpm (or smaller) increments and capable of indicating engine speed from 0-5000 rpm shall be installed on the vehicle. Analog tachometers are preferable.

One calibrated vacuum gauge, graduated in one-half inch of mercury (or smaller) increments and capable of indicating vacuum from 0-24 inches of mercury (0-81 kPa) shall be connected to the intake manifold. For vehicles with turbochargers or superchargers, a compound vacuum/pressure gauge should be used; the pressure side of the gauge should be capable of indicating pressures up to 15 psig (103 kPa).

An auxiliary fuel system shall be provided to supply test fuels to the engine. Fuel pressure and fuel line size should meet manufacturer's specifications. Auxiliary fuel systems are fuel-system-type-specified and instructions are given in Appendix A.

C. Data Recording

Record vehicle identification number and emission control type, Federal, Altitude, California, or Fifty-State. Fill in headings on Data Form ONRS-MY, Sides A and C. Ford emission calibration numbers are to be recorded.

Record basic spark timing before adjustment to manufacturer's specifications.

For vehicles with owner questionnaire completed for the ONRS, a sample of the tank gasoline shall be withdrawn for determination of Research and Motor octane number ratings. If insufficient fuel is available, omit this step and tank fuel observations.

IV. TEST CONDITIONS

All octane number requirements will be determined under level road acceleration conditions. Noise in the passenger compartment should be similar to noise encountered during normal road conditions. Windows should be closed or sealed, and the radio should be off. If testing is to be conducted on a chassis dynamometer, coastdown and/or acceleration data should be used to determine dynamometer load (level road conditions).

Tests will be conducted in moderately dry conditions, preferably at ambient temperatures between 60°F (16°C) and 90°F (32°C). Tests should not be conducted during periods of high humidity such as prevail when rain is threatening or during or immediately after a rain storm. Laboratories with control capabilities should target for 70°F (21°C) air temperature and 50 grains of water per pound (7.14 gm/kg) of dry air whenever possible. Record temperature, pressure, and humidity on the data form.

To stabilize engine temperatures, a minimum of ten miles of warm-up is required. The test vehicle should be operated at 55-70 mph (88-113 kph) in top gear with a minimum of full-throttle operation.

During the warm-up period, the general mechanical condition of the vehicle should be checked to ensure satisfactory and safe operation during test work.

Air-conditioned vehicles will be tested with air conditioner turned ON in the normal mode, set at a comfortable temperature, with low fan.

V. FUELS

Octane number requirements are determined using the vehicle's tank fuel, and three reference fuel series.

Vehicle tank fuel is tested to obtain a preliminary indication of the vehicle octane number requirement. It will also be octane-rated and data included on Data Form ONRS-MY, Side A, if an Owner's Questionnaire Form ONRS-MY, Side E has been completed.

Octane number requirements are also determined using three reference fuel series. Two are designed using typical refinery components and are blended from three base blends in one or two Research octane numbers (RON) increments.

Full-Boiling Range Unleaded (FBRU) fuels are blended to a typical octane sensitivity. Octane sensitivity is defined as the difference between the fuel's RON and Motor octane number (MON) ratings.

Full-Boiling Range Sensitive Unleaded (FBRSU) fuels are blended to a target sensitivity two octane numbers higher than the FBRU fuel.

Primary Reference (PR) fuels comprise the third reference fuel series and are a volume blend of two components, isooctane and normal heptane. PR fuels are blended in one or two octane number increments, and by definition have zero sensitivity. PR fuels are defined in ASTM D2699 and D2700 test procedures.

Fuels are tested in a specific order. Tank fuel is tested first. The reference fuels are tested in order of descending sensitivity, starting with FBRSU, then testing with FBRU, and finishing with PR.

VI. DETERMINATION OF AUTOMATIC TRANSMISSION CHARACTERISTICS

Automatic transmission vehicles should be tested with the gear selector in the top forward gear, normally found to the right or below neutral; top gear should not be locked out unless noted otherwise by the manufacturer. Transmissions equipped with automatic overdrive should be operated in overdrive unless noted otherwise by the manufacturer. Transmissions equipped with power/normal selection should be operated in the normal position.

Do not use brakes, turn signals, or hazard flashers during accelerations, as these may affect electronic engine controls.

Determine the minimum road speed for converter clutch applications in each gear by gentle acceleration from the minimum speed to obtain the gear until the converter clutch engages. Record manifold vacuum, engine rpm, and vehicle speed on Data Form ONRS-MY, Side B.

Obtain the transmission downshift characteristics to define the detent curve for the gear/converter clutch combination.

1) Starting from a constant speed of 25 mph (40 kph), open the throttle until downshift occurs. Observe manifold vacuum and engine rpm.

2) Repeat Step 1 at higher vacuums until a vacuum is found which does not cause downshift. Record vacuum and rpm.

3) Repeat Steps 1 and 2, starting, in succession, from 35, 45, 55, and 65 mph (56, 72, 88, and 105 kph), and in all available gear/converter clutch combinations available at each speed.

VII. DRIVING PROCEDURES

Octane number requirements will be evaluated under both full-throttle and part-throttle accelerations. The vehicles will be evaluated to determine the transmission gear position and throttle position of maximum knock intensity, which is the critical operating condition.

A. Manual Transmissions

Accelerations will not be made in all transmission gears. Accelerations and critical vacuum/pressure determinations will be investigated per the following gear selection table:

5-speed	4th and 3rd gears
4-speed	4th and 3rd gears
3-speed	3rd and 2nd gears

Accelerations will start from the lowest speed from which the vehicle will accelerate smoothly or 25 mph (40 kph), whichever is higher.

Full-throttle accelerations are made with the throttle fully depressed.

Part-throttle accelerations are made with the throttle depressed at least one inch Hg (3.3 kPa) higher than the full-throttle manifold vacuum/pressure. Part-throttle accelerations start at the minimum obtainable speed in the test gear to 70 mph (113 kph), or until the vehicle ceases to accelerate reasonably. Part-throttle accelerations to measure vehicle octane number requirements are performed at critical vacuum/pressures.

To obtain critical part-throttle vacuum/pressure, operate at constant speed road load at 25, 35, 45, 55, and 65 mph (40, 56, 72, 88, and 105 kph) incremental speeds. At each speed, move the throttle from road load vacuum to the positions described below:

For naturally-aspirated vehicles, one inch Hg (3.3 kPa) above full-throttle vacuum;

For turbocharged vehicles, one inch Hg (0.5 psig or 3.3 kPa) below maximum boost.

The throttle movement from road load to the prescribed position should take place in approximately three seconds. This procedure is called fanning. If knocking occurs within any of the vacuum/pressure ranges, establish the manifold vacuum/pressure which gives maximum knock intensity. This is the critical vacuum/pressure to be used for all subsequent constant-vacuum/pressure part-throttle accelerations.

The critical part-throttle vacuum/pressure may be different for other fuel series and must be reinvestigated for each series.

Use of vehicle brakes must be avoided.

B. Automatic Transmissions

Accelerations must be made with the selector in the top forward gear, normally found to the right or below neutral; top gear should not be locked out. Transmissions equipped with electronic overdrive should be operated in overdrive. Transmissions equipped with power/normal selections should be operated in the normal position.

Accelerations will not be made in all transmissions gears. Accelerations and critical vacuum/pressure determinations will be done as shown in the following gear table. If a particular gear/lock-up combination cannot be obtained, it will not be tested.

Type	Gears to be Tested
4-speed with torque converter lock-up	4th gear, converter clutch engaged 4th gear, converter clutch disengaged 3rd gear, converter clutch engaged 3rd gear, converter clutch disengaged 2nd gear, converter clutch disengaged
4-speed without torque converter lock-up	4th gear 3rd gear 2nd gear
3-speed with torque converter lock-up	3rd gear, converter clutch engaged 3rd gear, converter clutch disengaged 2nd gear, converter clutch disengaged
3-speed without torque converter lock-up	3rd gear 2nd gear

Accelerations in each of the transmission gears or gear/converter clutch combinations specified above will start from the minimum obtainable road speed and continue until maximum test speed is obtained or, in the case of part-throttle, the vehicle ceases to accelerate reasonably. Minimum obtainable road speeds were established when automatic transmission characteristics were investigated in Section VI. Maximum test speed is 70 mph or a road speed corresponding to 750 rpm above maximum torque, whichever is lower. If the transmissions downshifts, abort and start the acceleration again.

Full-throttle accelerations are made with the throttle depressed in the widest throttle position that does not cause the transmission to downshift or the torque converter clutch to disengage. These accelerations are made following the speed-vacuum/pressure curves established in Section VI.

Part-throttle accelerations are made with the throttle depressed at least one inch Hg (3.3 kPa) higher than the full-throttle manifold vacuum/pressure. Part-throttle accelerations start at the minimum obtainable speed in the test gear to 70 mph (113 kph), or until the vehicle ceases to accelerate reasonably. Part-throttle accelerations to measure vehicle octane number requirements are performed at critical vacuum/pressures.

The critical part-throttle vacuum/pressure investigations will be conducted in the two highest transmission gear positions with the available combinations of converter clutch locked or unlocked. Investigation of critical condition should start with the highest transmission gear with converter clutch engaged. Begin from road load speed of 25 mph (40 kph) or minimum obtainable road speed for the gear/converter clutch combination. Continue the investigation at speeds of 35, 45, 55, and 65 mph (56, 72, 88, and 105 kph), if obtainable.

At each speed, move the throttle from the road-load vacuum/pressure to the detent or torque converter declutch position described below. This throttle maneuver should be accomplished in about three seconds, and is called fanning.

1. For naturally aspirated vehicles, one inch Hg (3.3 kPa) above:

   a. detent vacuum for automatic transmissions without converter clutches;

   b. the minimum vacuum at which the converter clutch disengages for so-equipped automatic transmissions.

2. For turbocharged vehicles, one inch Hg or 0.5 psig (3.3 kPa) below:

   a. maximum boost at detent for automatic transmissions without converter clutches;

   b. maximum boost or 0.5 psig (3.3 kPa) above the minimum vacuum at which the converter clutch disengages for so-equipped automatic transmissions.

If knocking occurs within any of the vacuum/pressure ranges, establish the manifold vacuum/pressure which gives maximum knock intensity. This is the critical vacuum/pressure to be used for all subsequent constant-vacuum/pressure part-throttle accelerations.

The critical part-throttle vacuum/pressure may be different for other fuel series and must be investigated for each series.

If knock is encountered during the fanning procedure but not during the constant-vacuum/pressure part-throttle accelerations, it should be recorded as tip-in.

Use of vehicle brakes must be avoided

VIII. TEST PROCEDURE

A. Fuel Changeover

To eliminate contamination of the new fuel with residual amounts of the previous fuel, fuel-injected systems should be flushed once with the new fuel and carbureted systems should be flushed twice. Fuel-handling procedures for vehicles equipped with fuel injection systems are explained in Appendix A.

Make one full throttle acceleration after the fuel change.

B. Determination of Knock Intensity

Spark knock is the noise associated with the autoignition* of a portion of the fuel-air mixture ahead of the advancing flame front. It is recurrent and repeatable in terms of audibility and fuel octane quality. This includes knock occurring when going from road load to other operating conditions (e.g., tip-in, etc.)

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*Autoignition: The spontaneous ignition and the resulting very rapid reaction of a portion or all of the fuel-air mixture. The flame speed is many, many times greater than that which follows normal spark ignition. There is no time reference for autoignition.

Borderline knock is spark knock of lowest audible intensity of at least three pings, and over a range of engine speed of 50 rpm or more, all being repeatable during subsequent accelerations and being sensitive to fuel octane.

No knock means either no audible knock or knock less than borderline intensity.

Above-borderline knock means spark knock of greater audible intensity (louder) than borderline and sensitive to fuel octane quality. There is no restriction on number of pings.

Knock-in is the rpm at which knock is first encountered. Knock-out is the rpm at which knock is last encountered.

Maximum octane requirements will be established by evaluating the occurrence of knock in terms of knock intensity: "N" for none, "B" for borderline, and "A" for above borderline. Establishment of representative knock intensity for a given fuel will be accomplished with a maximum of three (3) rated accelerations. Coastdown time between the end of one acceleration and the beginning of the next should be consistent and a minimum of twenty (20) seconds. As defined below, the first two duplicating accelerations are sufficient with "N" and "B" intensity.

"A" knock intensity must not be maintained during an acceleration. If "A" knock intensity occurs, back off the throttle from detent, maintaining "B" level knock by approaching the detent curve as knock fades. Do not duplicate this acceleration. Testing will continue with a higher octane number fuel in that series.

Maximum Octane Number Requirement Determination

Acceleration Number			Representative Rating
1	2	3	
N	N	-	N
N	B	N	N
N	B	B	B
B	N	B	B
B	B	-	B
B	A	-	A
A	-	-	A

C. Tank Fuel

Knock on tank fuel is determined for those ONRS vehicles which have a completed owner's questionnaire. Investigate for full-throttle and part-throttle knock in each of the gears or gear/converter clutch combinations shown in the transmission characteristics table in Section VII A and B. Record knock intensity, engine speed, and manifold vacuum/pressure at each operating condition.

D. FBRSU and PR Fuel Series

The test procedures used for the FBRSU and PR fuel series are the same, although the FBRU series is tested after FBRSU and before PR. Knock is investigated in all fuel series in each of the gears or gear/converter clutch combinations shown in the transmission characteristics table in Section VII A and B.

Estimate which fuel will give borderline knock. For the FBRSU series, this estimate is based on tank fuel information, while for the PR series, it is based on data from the FBRSU and FBRU series. The steps in determining the octane requirement of the vehicle on these fuel series include several decision points and are illustrated on page 30 in a flow sheet.

E. FBRU Series

Based on the results of tests on the FBRSU series, estimate which fuel will give borderline knock. The flow sheet which gives the steps for octane rating a vehicle on FBRU series begins on page 15. Testing on the FBRU series is more extensive than testing on FBRSU or PR series. If the vehicle is full-throttle limited, part-throttle conditions are investigated up to four octane numbers below the full-throttle requirement.

IX. DATA SUMMARY

A. Raw Data Entry

The purpose of the raw data record is to allow anyone familiar with the rating procedure to independently determine the actual test performed. The original data will be recorded on Form ONRS-MY, Sides C and D, which is the first and permanent record of the results of the rating. This means that data sheets must not be rewritten or typed. In case an error is made, draw a line through the error. Do not erase. All fuels tested must be recorded on Sides C and D whether or not knock is encountered.

B. Vehicle and Test Condition Data

Vehicle and test condition data are recorded on Form ONRS-MY, Side A. Many of the data required are further explained in the footnotes on Side D. Care should be taken to record data in the units printed on the form or using the codes on the form and explained in the footnotes. Special care should be taken to record the VIN correctly, because this information is crucial to properly assigning the vehicle to the correct Survey vehicle code.

If knock is encountered on tank fuel in more than one throttle and/or gear position, the knocking condition to record is the condition of most intense knock. If maximum- and part-throttle knock are of equal intensity, record the part-throttle condition. If two or more gear/torque converter conditions knock with equal intensity, record the highest gear/torque converter condition. If no knock are encountered, no further data are recorded.

C. Octane Number Requirement Summary

The octane number requirement summary block is on the bottom part of Form ONRS-MY, Side A. The data in this block are derived from the original data on Sides C and D. The summary block provides space for both maximum-throttle and part-throttle requirements for the maximum octane requirement for all vehicles. If both maximum-throttle and part-throttle requirements have been found, record both.

Use proper letter designations (see the footnotes on the data sheet) to designate: (1) requirements outside of the reference fuel limits; (2) FBRU part-throttle requirement more than four numbers below maximum; and (3) all other cases for which the octane number requirement has not been determined. Note that in the case of a converter-clutch-equipped vehicle, test gear numbers should indicate whether the converter clutch was locked or unlocked. This should be done for all gears. Note also that in the case of turbocharged or supercharged vehicles, a manifold pressure above atmospheric is indicated as a negative number in units of psig.

When deriving summary data from the raw data, the following guidelines shall be used.

1. If the knock intensity of the highest reference fuel giving knock is borderline, the requirement shall be reported as the octane number of that fuel.

2. If the knock intensity of the highest fuel giving knock is above borderline, the requirement shall be reported as the mid-point between the octane number of the fuel giving knock and that of the next higher fuel.

3. If the octane number requirement in high gear is equal to the requirement in a lower gear, report the highest gear data. Locked condition is higher than unlocked.

4. For part-throttle requirements, report the data from the critical manifold vacuum/pressure observations.

X. GLOSSARY TERMS

A	=	Above-Borderline Knock (see Section VIII B)
B	=	Borderline Knock (see Section VIII B)
BTDC	=	Before Top Dead Center
Critical Manifold Vacuum/Pressure	=	the manifold vacuum/pressure which gives maximum knock intensity during a P/T acceleration (see Section VII)
Detent	=	Throttle position at any speed which is at the point of incipient downshift. (see Section VI)
EGR Valve	=	Exhaust Gas Recirculation Valve
FBRU	=	Full-Boiling Range Unleaded Average Sensitivity Fuel (see Section V)
FBRSU	=	Full-Boiling Range Unleaded High Sensitivity Fuel (see Section V)
F/T	=	Full-Throttle (see Section VII A)
Gr/lb	=	Grains of water per pound of air
GVW	=	Gross Vehicle Weight
Hg	=	Mercury
kg	=	kilogram
Km	=	Kilometers
Knock-In	=	the rpm at which knock is first encountered (see Section VIII B)
Knock-Out	=	the rpm at which knock is last encountered (see Section VIII B)
kPa	=	kilo Paschal
kph	=	kilometers per hour
lb	=	pound
MAX	=	Maximum

Maximum Requirement/Maximum Octane Number Requirement = the highest octane number fuel in a fuel series which causes borderline knock in at least one engine condition (see Section II A)

MON	=	Motor Octane Number
mph	=	miles per hour
N	=	No Knock (see Section VIII B)
ON	=	Octane Number
PCV Valve	=	Positive Crankcase Ventilation Valve
PFI	=	Port Fuel Injection
PR	=	Primary Reference Fuel (see Section V)
psig	=	pounds per square inch gauge
P/T	=	Part-Throttle (see Section VII A)
RON	=	Research Octane Number
RPM	=	Revolutions per minute
TBI	=	Throttle-Body Fuel Injection
TC	=	Torque Converter
TDC	=	Top Dead Center

DEFINITIONS AND DESCRIPTIONS FOR OCTANE TEST PROCEDURE GUIDE

A = Above Borderline Knock

B = Borderline Knock

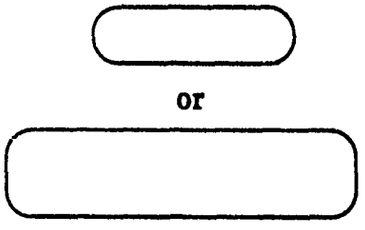
N = No Knock

ON = Octane Number

F/T = Full Throttle

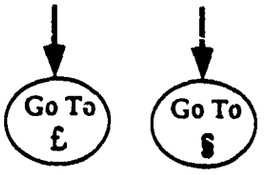
P/T = Part Throttle

Gear/TC = Gear/Torque Converter



or = Decision Point

or = Operation



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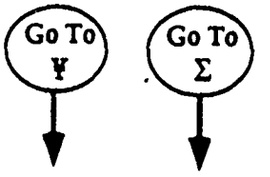

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= Pathway

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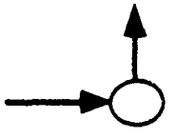

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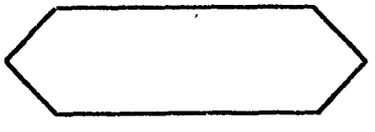

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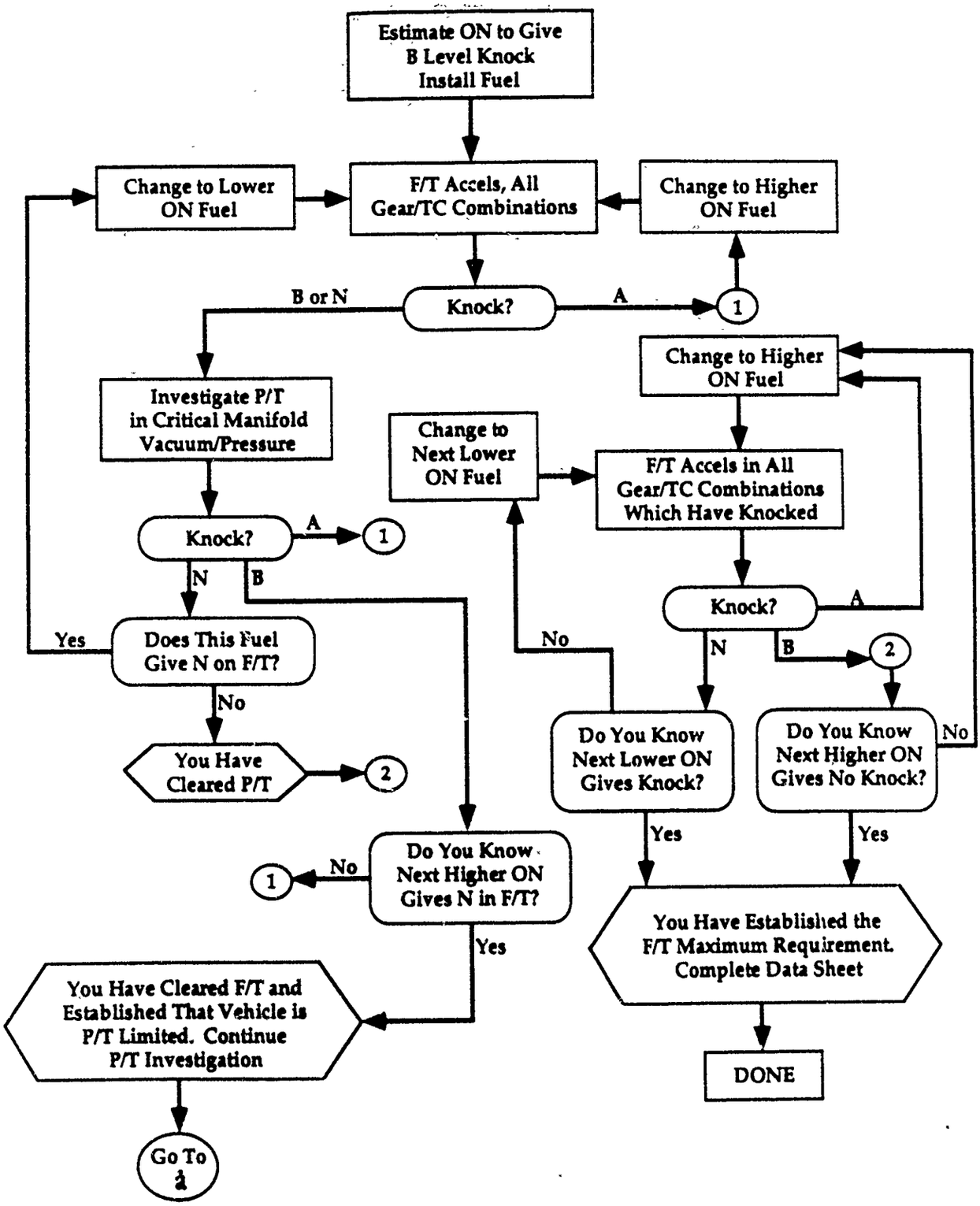
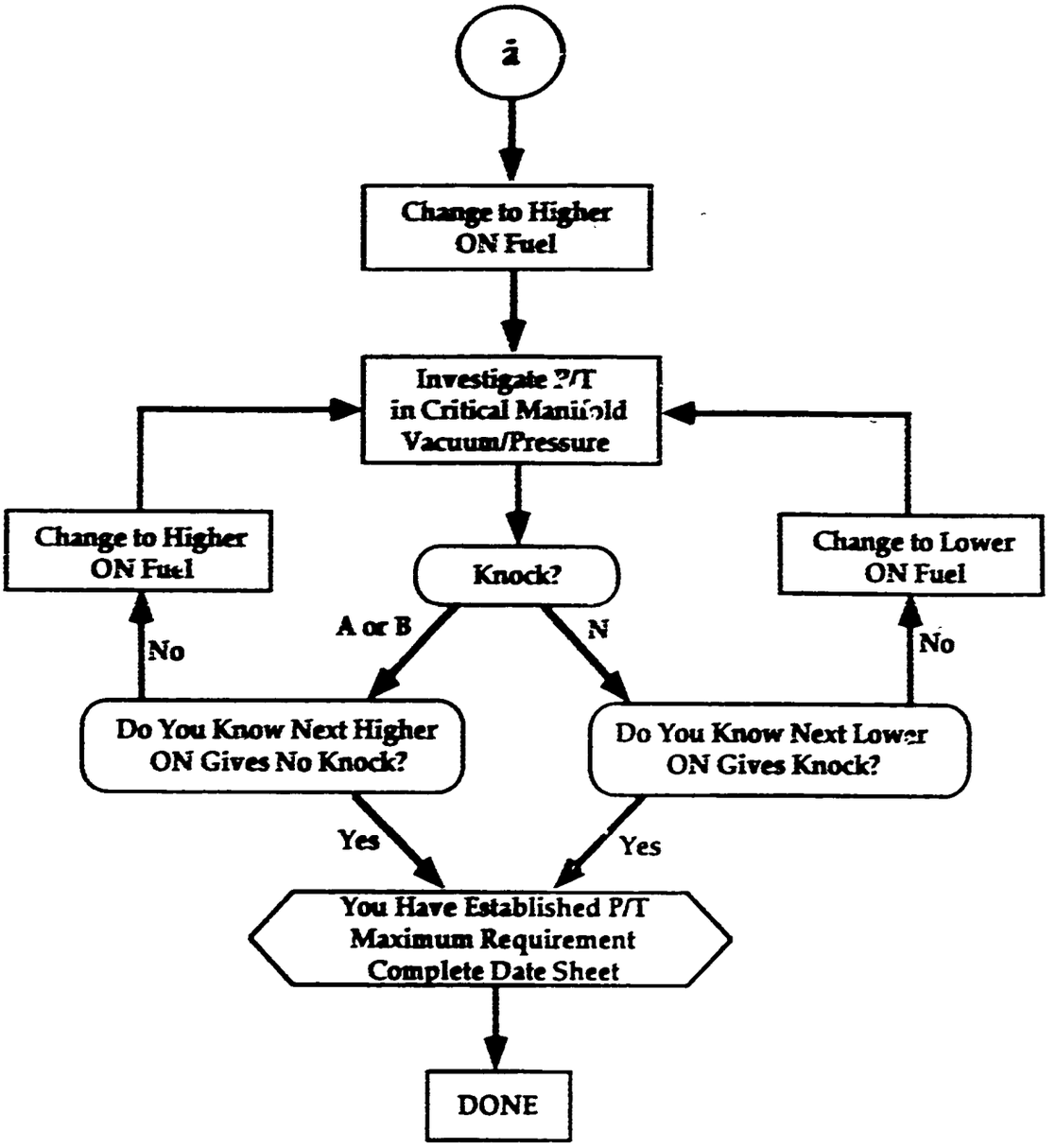
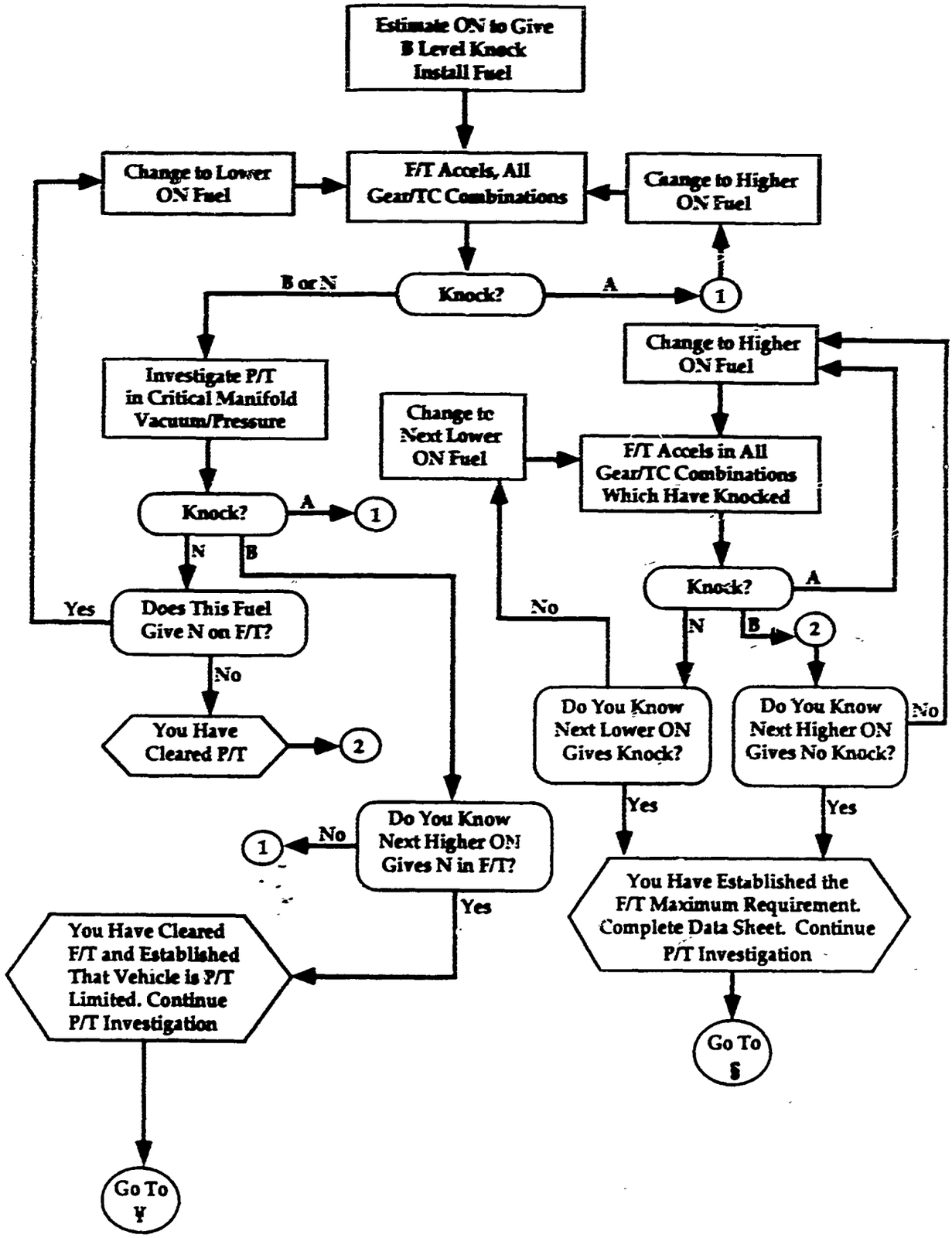
OCTANE TEST PROCEDURE GUIDE FOR FBRSU AND PR FUEL SERIES

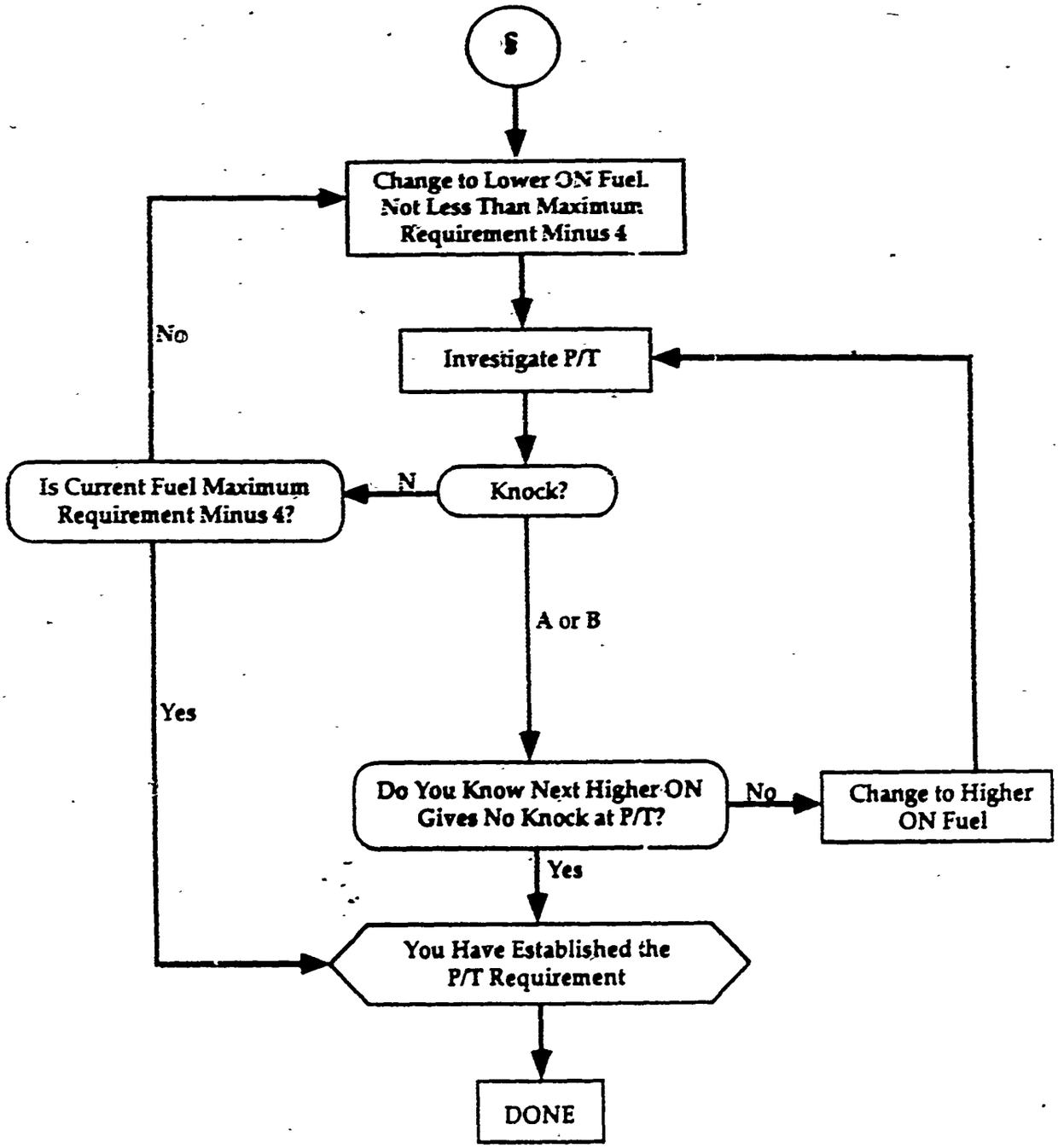



a
Change to Higher ON Fuel
Investigate P/T in Critical Manifold Vacuum/Pressure
Change to Higher ON Fuel
Knock?
Change to Lower ON Fuel
A or B
N
No
No
Do You Know Next Higher ON Gives No Knock?
Do You Know Next Lower ON Gives Knock?
Yes
Yes
You Have Established P/T Maximum Requirement Complete Date Sheet
DONE

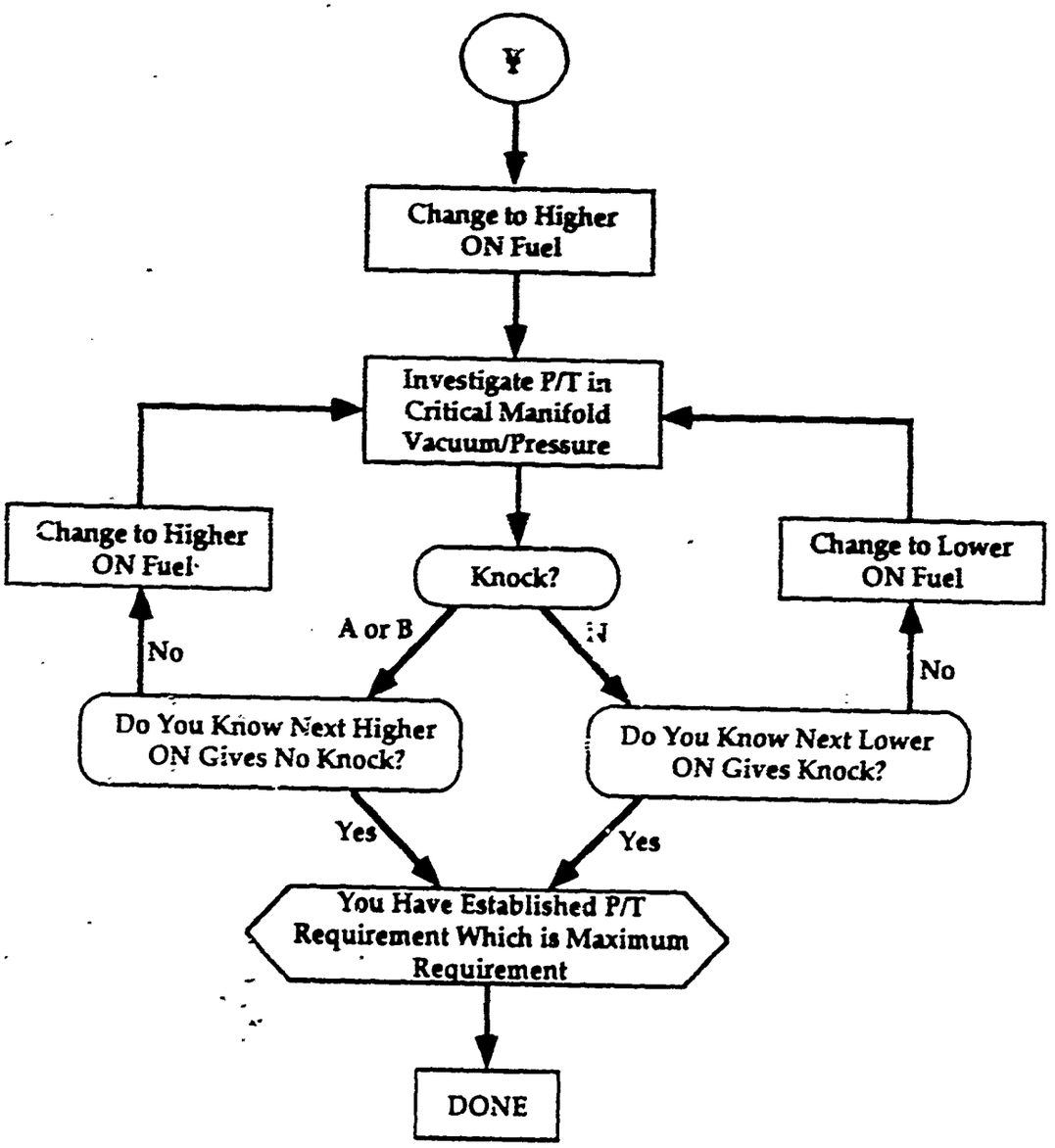
OCTANE TEST PROCEDURE GUIDE FOR FBRU FUEL SERIES



P/T Investigation For Vehicles With Maximum Requirement at F/T



Investigation of Maximum Requirement at P/T for P/T Limited Vehicles



A P P E N D I X E

1990 OCTANE NUMBER REQUIREMENT SURVEY DATA

GLOSSARY

(For Appendix E Only)

Vehicle Type (TYPE):	C Passenger car T Light-duty truck or van
Emission Certification (EMCT):	A Altitude C California F Federal E Everything
Knock Sensor (KS):	H Maximum Requirement L Minimum-Borderline Requirement N No
F/A System (F/A SYS):	If single character: T Throttle-body fuel injection P Multiple-port fuel injection # Carburetor where # is no. venturi If two characters, second character is as above, and first character is: T Turbo S Supercharger
Displacement (DSP):	Engine Displacement in liters
Transmission (TRANS):	First character: M Manual shift A Automatic shift Second character is number of forward gears
Air Conditioner (AIR):	Y Yes N No
Spark Advance:	+ Before Top Center - After Top Center
Test Fuel:	1 Tank Fuel 2 FBRSU 3 FBRU 4 PR

Octane Number Requirements: (expressed as Research ON)	L	Less than lowest available ON for FBRU and FBRSU fuels and less than 76 for PR fuels
	H	Higher than highest available ON for FBRU and FBRSU fuels and higher than 100 ON for PR fuels
	F	Part-throttle requirement greater than four numbers below maximum-throttle requirement
Throttle (THR):	M	Maximum
	P	Part
Gear:	1-5	Manual and Automatic
	U	Not tested in lockup (torque converter not engaged)
	L	Tested in lockup (torgue converter engaged)
Manifold Vacuum (VAC):	Inches Hg, positive for vacuum, negative (-) for pressure	
Owner-Reported Knock (OWKNK):	Y	Yes, Not Objectionable
	O	Objectionable
	N	No
Rater-Reported Noise Intensity (KNINT)	N	None
	B	Borderline
	A	Above Borderline

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

	VEHICLE DESCRIPTION											WEATHER			OCTANE NUMBER REQUIREMENT DATA									TANK FUEL INFORMATION							
																MAXIMUM				PART-THROTTLE							RATER				
									SPARK ADVANCE																						
OBS. NO.	TYPE	EMCT	KS	F/A SYS	DSP	TRANS	C.R.	AIR	AS RCD	AS TST	ODOM MILES	AMB TMP	BAROM	HUM	FUEL	OCT NO	GEAR	RPM	VAC	OCT NO	GEAR	RPM	VAC	OWKNK	OCT NO RES	OCT NO MOTR	KNINT	THR	GEAR	RPM	VAC
28-22	C	F	N	T	1.0	M5	9.5	Y	+ 6	+ 6	10114	70	29.22	50	3	85.0	3	1000	1.0	86.0	3	1000	7.0								
															2	88.0	3	1000	1.0	89.0	3	1000	9.0								
															4	84.0	4	1200	0.5												
46-16	C	E	N	T	1.0	M5	9.5	Y	+ 6	+ 6	9849	72	29.20	50	3	81.0	4	3000	0.0	F				N	92.8	82.0					
															2					81.0	4	1700	0.0								
															4	81.0	4	2975	0.0												
46-08	C	E	N	T	1.5	M5	9.2	Y	+18	+18	9898	71	29.27	91	3	86.0	3	2500	0.5	84.0	4	2325	1.5	N	91.3	83.4	N				
															2	87.0	3	2500	0.5												
															4	85.0	3	3100	0.5												
47-18	C	C	N	T	1.5	M5	9.2	Y	+18	+18	12000	70	29.99	52	3	93.0	4	3000	0.0	92.0	4	3000	1.0								
															2	93.0	4	4000	0.0												
															4	93.0	4	2000	0.0												
26-24	C	F	N	T	1.5	A4	9.2	Y	+18	+18	9344	78	29.89	124	3	L				L											
															2	L				L											
															4	L				L											
65-12	C	F	N	2	1.5	M5	9.4	N	+ 5	+ 5	11900	76	29.40	80	3	90.0	4	1400	0.0	89.5	4	1400	2.0								
															2	90.5	4	1400	0.0												
															4	91.5	4	1400	0.0												
60-03	C	F	N	1	1.5	A3	9.3	Y	+ 3	+ 3	13726	72	28.96	38	3	80.0	3L	2800	1.6	L											
															2	82.0	3L	2800	1.6	L											
															4																
47-11	C	C	N	P	1.5	A3	9.3	Y	+10	+10	9200	70	29.92	62	3	90.5	2U	4500	0.5	90.0	3L	2250	11.0								
															2	91.5	2U	4500	0.5												
															4	88.0	3U	2600	0.5												
29-18	C	F	N	T	1.6	A3	9.5	Y	+10	+10	7230	70	29.50	55	3	91.0	3L	3150	0.4	88.0	3L	2550	5.5								
															2	92.0	3U	2500	0.4												
															4	90.0	3L	3200	0.4												
41-15	C	C	N	P	1.6	A4	9.1	Y	+18	+18	13073	77	30.00	45	3	93.0	4L	2900	0.5	F				N			N				
															2	94.0	3U	3000	0.5												
															4	91.0	4L	2850	0.5												
06-04	C	F	N	T	1.6	M4	9.4	N	-7	-7	10824	78	29.89	127	3	83.0	3	2400	1.0	82.0	4	1600	3.0	N	99.5	88.3	N				
															2	85.0	3	2400	1.0												
															4	82.0	4	1700	1.0												

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

	VEHICLE DESCRIPTION											WEATHER			OCTANE NUMBER REQUIREMENT DATA									TANK FUEL INFORMATION							
																MAXIMUM				PART-THROTTLE							RATER				
OBS. NO.	TYPE	EMCT	KS	F/A SYS	DSP	TRANS	C.R.	AIR	SPARK ADVANCE AS RCD	SPARK ADVANCE AS TST	ODOM. MILES	AMB TMP	BAROM	HUM	FUEL	OCT NO	GEAR	RPM	VAC	OCT NO	GEAR	RPM	VAC	OWNK	OCT NO RES	OCT NO MOTR	KNINT	THR	GEAR	RPM	VAC
47-29	C	C	N	T	1.6	M4	9.4	Y	+ 7	+ 7	16630	70	30.16	50	3	90.0	4	1500	0.2	93.0	4	1500	1.2								
															2	90.0	4	1500	0.2												
															4	90.0	4	1700	0.2												
05-13	C	F	N	T	1.6	M5	9.4	Y	+ 7	+ 7	10096	70	29.91	50	3	87.0	3	2100	0.6	F				N	97.4	86.0	N				
															2	87.0	3	1900	0.6	86.0	3	1120	2.4								
															4	87.0	3	1200	0.4												
47-22	C	C	N	T	1.6	M5	9.4	Y	+ 7	+ 7	13500	70	29.92	62	3	91.0	4	1250	0.0	92.0	4	1500	6.0	N	98.1	87.0	N				
															2	91.0	4	1250	0.0												
															4	91.0	4	1200	0.0												
41-17	C	C	N	T	1.6	A3	9.4	Y	+ 7	+ 7	12965	82	30.06	32	3	88.0	3L	3200	1.0	85.0	3L	3200	3.2								
															2	88.0	3L	3100	1.0	88.0	3L	3000	3.0								
															4	87.0	3U	2200	0.9												
62-01	C	F	N	T	1.6	A3	9.4	Y	+ 7	+ 7	10782	73	29.52	40	3	89.0	3U	2450	1.2	F											
															2	89.0	2U	3000	1.4												
															4																
06-10	C	F	N	P	1.6	M5	9.5	Y	-10	-10	6215	92	30.15	98	3	87.0	4	3400	0.4	85.0	4	2000	2.0	Y			A	M	4		0.4
															2	89.0	4	1500	0.4												
															4	85.0	4	2000	0.4												
06-24	C	F	N	P	1.6	A3	9.5	Y	+10	+10	7792	80	30.11	78	3	88.0	3L	1900	0.4	87.0	3L	1900	2.0	N			N				
															2	90.0	3L	2000	0.4												
															4	88.0	3L	2100	0.4												
08-11	C	F	N	P	1.6	A3	9.5	Y	+10	+10	15470	79	29.84	35	3	92.0	3U	2500	0.6	92.0	3U	2450	2.5								
															2	94.0	2U	3500	0.5	94.0	3U	2500	2.5								
															4	89.0	2U	3600	0.5												
41-03	C	C	N	P	1.6	A3	9.5	Y	+10	+10	15783	70	29.93	52	3	89.5	3U		0.2												
															2	91.0	3U	2500	0.2												
															4	87.0	3U	2700	0.2												
29-13	C	F	N	P	1.6	A3	9.5	Y	+10	+10	6309	70	29.65	55	3	91.0	2U	3100	0.5	90.0	3L	2750	2.0								
															2	92.0	2U	3300	0.5												
															4	90.5	2U	3300	0.5												
60-01	C	F	N	P	1.6	A3	9.5	Y	+10	+10	19384	73	29.59	48	3	84.0	3U	2700	0.6	L											
															2	84.0	3U	2700	0.6												
															4																

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

	VEHICLE DESCRIPTION										WEATHER			OCTANE NUMBER REQUIREMENT DATA								TANK FUEL INFORMATION							
							SPARK ADVANCE								MAXIMUM				PART-THROTTLE						RATER			
OBS. NO.	TYPE	EM SYS	F/A	TRANS	AIR	C.R.	RCD	TST	ODOM MILES	AMB TMP	BAROM	HUM	FUEL	OCT NO	GEAR	RPM	VAC	OCT NO	GEAR	RPM	VAC	OWK	OCT RES	NO MOTR	KNIT	GTEHA	RPM	VAC
60-05	C	F N	P	1.6	A3	9.5	Y	+10	+10	21532	75	29.93	32	3	82.0	2U	3300	1.4	82.0	2U	2600	2.4						
														2	84.0	2U	3200	1.4	82.0	2U	2600	2.4						
														4															
05-09	C	F N	P	1.8	M5	9.2	Y	+16	+16	25262	70	30.19	50	3	87.0	4	2800	0.2	87.0	4	1760	2.0	N	92.8	82.0	B	M 3	4100	0.5
														2	90.0	3	4000	0.5										
														4	87.0	4	2200	0.0										
41-25	C	C N	P	1.8	M5	9.2	Y	+16	+16	15182	80	29.65	35	3	87.5	4	2400	0.2	87.0	4	2550	1.6	N				N		
														2	91.0	3	4000	0.2	90.0	3	3500	1.6						
														4	89.0	4	2800	0.2										
29-30	C	F N	P	1.8	M5	9.2	N	+16	+16	6005	70	29.30	55	3	87.0	4	2300	0.0	86.5	4	2500	1.2						
														2	87.5	4	3000	0.0										
														4	87.0	4	2300	0.0										
06-08	C	F N	P	1.8	A4	9.2	Y	-16	-16	9774	82	30.16	102	3	88.0	3L	3000	0.4	84.0	3L	3000	2.5	N	98.9	88.4	N			
														2	90.0	3U	3000	3.0										
														4	86.0	4U	3000	1.0										
47-10	C	C Y	P	1.8	M5	10.0	Y			9550	70	30.00	50	3	88.0	3	1500	0.0	87.0	4	1500	0.0	N	98.0	87.0	N			
														2	88.0	3	1500	0.0										
														4	88.0	3	1500	0.0										
06-21	C	F Y	P	1.8	A3	10.0	Y			6210	84	29.90	117	3	96.0	3	2600	2.6	96.0	3	2600	5.0	N						
														2	96.0	3	2600	2.6										
														4	95.0	3	2600	2.6										
40-09	C	F Y	P	1.8	A3	10.0	Y			8727	76	29.71	77	3	88.5	2	2000	0.0	88.5	3	2300	8.0						
														2	89.5	2	2500	0.0	89.5	3	2500	4.0						
														4	87.5	2	2000	0.0										
28-15	C	F Y	SP	1.8	M5	8.0	Y			9596	70	29.42	50	3	L				L										
														2	L				L										
														4	79.0	4	1500	-2.0										
05-03	C	F N	T	1.9	A3	9.0	Y	+10	+10	13871	70	29.80	50	3	98.0	3	1410	1.0	F				N	92.0	82.3	A	P 3	1550	2.5
														2	100.0	3	1320	1.0										
														4	95.0	3	1450	1.0										
06-06	C	F N	T	1.9	A3	9.0	Y	+12	-10	11572	95	29.93	87	3	90.0	3	1600	0.4	86.0	3	1600	0.4	N	97.6	82.5	N			
														2	91.0	3	2000	0.4										
														4	89.0	3	1600	0.4										

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

	VEHICLE DESCRIPTION											WEATHER			OCTANE NUMBER REQUIREMENT DATA								TANK FUEL INFORMATION					
								SPARK ADVANCE							MAXIMUM				PART-THROTTLE					RATER			
OBS. NO.	TYPE	EM CT	F/A KS	SYS	TRANS DSP	TRANS	C.R.	AIR	AS RCD	AS TST	ODOM MILES	AMB TMP	BAROM	HUM	FUEL LEVEL	OCT NO	GEAR	RPM	VAC	OCT NO	GEAR	RPM	VAC	OWNK	OCT NO RES	OCT NO MOTR	KNIT	GTHR	GEAR RPM	VAC
41-23	C	C	N	T	1.9	A3	9.0	Y	+10	+10	23520	70	30.07	36	3	93.0	3	1700	1.1	89.0	3	1650	2.8							
															2	93.0	3	1500	1.1											
															4	91.0	3	1400	1.1											
47-02	C	C	N	T	1.9	A3	9.0	Y	+10	+10	9500	70	29.95	55	3	93.0	3	2000	0.4	91.0	3	2000	1.5							
															2	94.0	3	2200	0.4											
															4	91.0	3	1800	0.4											
08-09	C	F	N	T	2.0	A3	8.8	Y	+ 8	+ 8	9821	70	30.06	45	3	91.0	3L	2300	1.0	89.0	3U	2450	4.0							
															2	92.0	3U	2800	1.5											
															4	88.0	3L	2150	1.0											
08-30	C	F	N	T	2.0	A3	8.8	Y	+ 8	+ 8	27364	79	29.44	52	3	88.0	3L	1950	1.5	85.0	3L	1950	3.5							
															2	89.0	3L	2000	1.5											
															4	86.0	3L	2000	1.5											
29-11	C	F	N	T	2.0	A3	8.8	Y	+ 8	+ 8	14638	70	29.56	55	3	93.0	3L	2150	1.0	90.0	3L	2050	4.0							
															2	94.0	3L	2250	1.0											
															4	90.0	3L	2000	1.0											
65-02	C	F	N	T	2.0	A3	8.8	Y	+ 8	+ 8	6850	72	29.70	76	3	93.0	3L	2200	1.0	91.5	3L	2200	3.0							
															2	92.5	3L	2200	1.0											
															4	91.0	3L	2200	1.0											
40-05	C	F	N	P	2.0	A4	9.0	Y	+15	+15	8697	82	29.60	62	3	90.0	4	2300	99.9	88.0	4	2000	99.9							
															2	89.0	4	2400	99.9											
															4	88.0	4	2100	99.9											
06-19	C	F	N	P	2.0	M5	9.0	Y	-5	-5	12113	87	30.04	94	3	L								N	94.4	85.3	N			
															2	L														
															4	L														
28-09	C	F	N	P	2.0	A4	9.0	Y	+ 5	+ 5	9870	70	29.14	50	3	89.0	4U	2300	0.5	88.0	3U	2200	1.5							
															2	90.0	3U	2400	0.5											
															4	88.0	3U	2200	0.5											
41-24	C	C	Y	TP	2.0	A3	9.0	Y	+14	+16	8078	75	30.15	55	3	92.0	2	2650	-8.5	F											
															2	91.0	3	2850	-9.5											
															4	93.0	2	2700	-8.5											
06-05	C	F	N	P	2.0	A4	9.3	Y	-10	-10	6137	95	29.79	111	3	84.0	4L	1800	0.8	82.0	4L	1900	2.2							
															2	85.0	4L	1800	0.8											
															4	82.0	4L	1800	0.8											

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

	VEHICLE DESCRIPTION										WEATHER			OCTANE NUMBER REQUIREMENT DATA									TANK FUEL INFORMATION							
															MAXIMUM				PART-THROTTLE							RATER				
OBS. NO.	TYPE	EMCT	KS	F/A SYS	DSP	TRANS	C.R.	AIR	SPARK ADVANCE AS RCD	SPARK ADVANCE AS TST	ODOM MILES	AMB TMP	BAROM	HUM	FUEL	OCT NO	GEAR	RPM	VAC	OCT NO	GEAR	RPM	VAC	OWKNK	OCT NO RES	OCT NO MOTR	KNIT	THR	GEAR	RPM	VAC
08-06	C	F	N	P	2.0	A4	9.3	Y	+10	+10	8662	73	29.73	48	3	87.0	2U	2800	0.6	86.0	3U	1900	4.0								
															2	88.0	2U	2900	0.6												
															4	87.0	2U	2750	0.6												
08-19	C	F	N	P	2.0	A4	9.3	Y	+10	+10	14415	78	29.63	0	3	86.0	3U	2100	0.7	86.0	3U	1950	3.0								
															2	87.0	3U	2300	0.7	86.0	3U	2100	3.0								
															4	86.0	2U	2900	0.6												
41-08	C	C	N	P	2.0	A4	9.3	Y	+10	+10	11413	71	29.98	53	3	80.0	4L	1950	0.7	L											
															2	82.0	4L	2100	0.7												
															4	80.0	2U	4300	0.8												
65-14	C	F	N	P	2.0	A4	9.3	Y	+10	+10	22000	78	29.70	87	3	87.0	4L	1950	0.0	87.0	4L	1950	1.0								
															2	87.5	4L	1800	0.0												
															4	84.5	4L	2000	0.0												
60-02	C	F	N	P	2.0	A4	9.3	Y	+10	+10	20242	71	29.53	45	3	82.0	2U	3000	1.0	L											
															2	82.0	2U	3200	1.0												
															4																
07-18	C	F	N	P	2.0	A4	9.3	Y	+10	+10	11765	72	30.07	51	3	86.0	3U	2900	0.0												
															2	87.0	2U	3600	0.0												
															4	86.0	3U	2900	0.0												
08-15	C	A	N	T	2.2	A3	9.5	Y	+12	+12	14385	78	29.57	44	3	87.0	3U	2400	0.7	84.0	3U	2100	3.5								
															2	89.0	3U	2300	0.7												
															4	87.0	2U	3000	1.0												
08-13	C	A	N	T	2.2	A3	9.5	Y	+12	+12	22946	78	29.57	77	3	89.0	2U	2600	0.8	86.0	3U	1950	3.0								
															2	90.0	2U	2900	0.8												
															4	88.0	2U	2800	0.8												
08-26	C	A	N	T	2.2	A3	9.5	Y	+12	+12	28236	80	29.95	29	3	85.0	3L	2300	1.0	82.0	3U	2400	3.0								
															2	86.0	3U	2600	0.5												
															4	84.0	3U	2450	0.5												
05-29	C	F	Y	TP	2.2	M5	8.0	Y	+12	+12	8600	70	30.35	50	3					96.0	4	1800	-2.0								
															2					97.0	4	1986	-2.0								
															4					97.0	4	2280	-6.5								
25-09	C	E	N	T	2.2	A3	9.5	Y	+12	+12	7120	80	29.39	108	3	86.0	3U	2800	0.8	84.0	3U	2000	1.5	N	91.5	83.1	N				
															2	87.0	3U	2500	0.8												
															4	85.0	3U	2800	0.5												

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

	VEHICLE DESCRIPTION											WEATHER			OCTANE NUMBER REQUIREMENT DATA									TANK FUEL INFORMATION							
									SPARK ADVANCE							MAXIMUM				PART-THROTTLE							RATER				
OBS. NO.	TYPE	EMCT	KS	F/A SYS	DSP	TRANS	C.R.	AIR	AS RCD	AS TST	ODOM MILES	AMB TMP	BAROM	HUM	FUEL	OCT NO	GEAR	RPM	VAC	OCT NO	GEAR	RPM	VAC	OWKNK	OCT NO RES	OCT NO MOTR	KNINT	THR	GEAR	RPM	VAC
29-14	C	F	N	T	2.2	A3	9.5	Y	+12	+12	14131	70	29.65	55	3	91.0	3L	2500	0.8	89.0	3U	2700	2.0								
															2	93.0	2U	2700	0.5												
															4	89.0	2U	2200	0.5												
46-04	C	E	N	P	2.2	M5	8.6	Y	+ 6	+ 6	8739	74	28.63	88	3	88.0	3	1650	0.5	86.0	4	1750	1.5	N	91.3	83.8	N				
															2	89.0	4	2650	0.5												
															4	88.0	3	1550	0.5												
32-07	C	F	N	P	2.2	A4	8.6	Y	+ 6	+ 6	16299	70	29.25	50	3	85.0	3U	3300	1.0	85.0	3U	3400	2.0	N	92.0	82.8	N				
															2	86.0	3U	2600	1.0	86.0	3U	2700	2.0								
															4	85.0	3U	3300	1.0	85.0	3U	3400	2.0								
32-09	C	F	Y	TP	2.2	A4	7.8	Y	+10	+10	6650	70		50	3									N	91.3	83.1	N				
															2	86.0	4L	2200	-4.0	86.0	4L	2100	-3.0								
															4																
46-19	C	E	Y	TP	2.2	M5	7.8	Y	+ 9		8597	72	29.00	50	3	92.0	3	4050	-7.0	F				N	95.2	86.9					
															2	93.5	3	4000	-7.0												
															4	94.0	3	3875	-7.0												
05-14	C	F	N	T	2.2	A3	9.0	Y			9975	70	29.79	50	3	93.0	2U	2500	0.7	F											
															2	96.0	3U	3160	1.2												
															4	90.0	3L	1900	1.5												
06-03	C	F	N	T	2.2	A3	9.0	Y	-14	-14	9380	88		110	3	88.0	3L	3200	1.0	93.0	3L	3000	6.0	Y	95.3	84.6					
															2	90.5	3U	3100	1.0	96.5	3L	2700	6.0								
															4	86.0	3L	2200	1.0												
08-04	C	F	N	T	2.2	A3	9.0	Y			17649	70	29.98	33	3	91.0	3L	1900	1.8	90.0	3U	2200	7.0								
															2	92.0	3L	1950	1.8	92.0	3U	2200	7.0								
															4	89.0	3L	1800	1.8												
08-14	C	F	N	T	2.2	A3	9.0	Y			16587	78	29.97	48	3	89.0	3U	3000	1.2	87.0	3L	1650	4.0								
															2	90.0	3U	3000	1.2												
															4	86.0	3L	1800	1.8												
08-25	C	F	N	T	2.2	A3	9.0	Y			9694	76	29.79	31	3	85.0	3L	1600	2.0	84.0	3L	1450	4.5								
															2	86.0	3L	1600	2.0												
															4	82.0	3L	1[illegible]00	2.0												
28-06	C	F	N	T	2.2	A3	9.0	Y			10059	70	29.28	50	3	88.0	3L	1600	1.5	88.0	3L	1350	7.0								
															2	88.0	3L	1600	1.5	90.0	3L	1350	7.0								
															4	86.0	3L	1600	1.5												

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

	VEHICLE DESCRIPTION											WEATHER			OCTANE NUMBER REQUIREMENT DATA									TANK FUEL INFORMATION							
									SPARK ADVANCE							MAXIMUM				PART-THROTTLE							RATER				
OBS. NO.	TYPE	EMCT	KS	F/A SYS	DSP	TRANS	C.R.	AIR	AS RCD	AS TST	ODOM MILES	AMB TMP	BAROM	HUM	FUEL	OCT NO	GEAR	RPM	VAC	OCT NO	GEAR	RPM	VAC	OWNK	OCT NO RES	OCT NO MOTR	KNINT	THR	GEAR	RPM	VAC
28-31	C	F	N	T	2.2	A3	9.0	Y			7191	70	29.00	50	3	88.0	3L	1400	1.7	86.0	3L	1500	3.0								
															2	88.0	3L	1400	1.7												
															4	87.0	3L	1400	1.7												
26-05	C	F	N	T	2.2	A3	9.0	Y			9306	70	29.92	61	3	92.0	3U	3125	0.5	89.0	3L	1950	5.0								
															2	93.0	3U	3025	0.5												
															4	90.0	2U	2600	1.0												
26-09	C	F	N	T	2.2	A3	9.0	Y			11298	88	30.03	87	3	94.0	3U	2200	0.5	94.0	3U	2200	4.0								
															2	94.0	2U	1400	0.5												
															4	93.0	3L	2100	0.1												
47-14	C	C	N	T	2.2	A3	9.0	Y			16250	70	29.92	50	3	93.0	3L	2250	1.0	100.0	3L	1600	10.0								
															2	93.0	3L	2250	1.0												
															4	90.0	3L	1650	1.0												
55-20	C	F	N	T	2.2	A3	9.0	Y			13700	75	29.70	43	3	94.0	3U	3050	1.0	93.0	3L	2100	4.0	N	97.2	86.5	N				
															2	95.0	3U	2800	1.0												
															4	89.0	3L	2200	1.5												
03-08	C	F	N	T	2.2	A3	9.0	Y			6190	70	29.64	45	3	88.0	3U	3025	1.2	87.0	3U	2350	6.0								
															2	89.0	3U	3000	1.2												
															4	86.0	2U	3000	0.8												
03-12	C	F	N	T	2.2	A3	9.0	Y			10756	81	29.98	62	3	88.0	2U	3150	0.8	F											
															2	89.0	3U	2975	0.8												
															4	86.0	3U	3000	1.2												
28-30	C	F	N	T	2.2	A3	9.0	Y			12866	70	29.50	50	3	88.0	2U	2800	0.5	85.0	2U	2800	1.5								
															2	89.0	2U	2900	0.5												
															4	86.0	2U	2800	0.5												
65-18	C	F	N	T	2.2	A3	9.0	Y	---		7600	76	29.60	80	3	85.5	2U	3000	0.5	85.0	3L	2000	3.5								
															2	87.0	2U	3000	0.5												
															4	83.0	2U	3000	0.5												
05-10	C	F	N	P	2.2	M5	8.8	Y	+15	+15	5320	68	30.20	45	3	91.0	3	3600	0.5					N	93.9	83.9	N				
															2	93.0	3	3200	0.5												
															4	90.0	3	2200	0.5												
47-19	C	C	N	P	2.2	M5	8.8	Y	+15	+15	8900	70	29.94	52	3	89.0	4	3600	0.0	88.0	4	3600	1.0								
															2	90.0	4	3700	0.0												
															4	88.0	4	2000	0.0												

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	VEHICLE DESCRIPTION											WEATHER			OCTANE NUMBER REQUIREMENT DATA									TANK FUEL INFORMATION							
									SPARK ADVANCE							MAXIMUM				PART-THROTTLE							RATER				
OBS. NO.	TYPE	EXCT	KS	F/A SYS	DSP	TRANS	C.R.	AIR	AS RCD	AS TST	ODOM MILES	AMB TMP	BAROM	HUM	FUEL	OCT NO	GEAR	RPM	VAC	OCT NO	GEAR	RPM	VAC	OWKNK	OCT NO RES	OCT NO MOTR	KNINT	TER	GEAR	RPM	VAC
06-02	C	F	N	P	2.2	A4	8.8	Y	-15	-15	10334	89	29.91	80	3	86.0	4	2700	0.4	85.0	4L	2700	2.0	N	92.1	81.6					
															2	86.0	4L	2600	0.8												
															4	84.0	4L	2700	0.8												
26-02	C	F	N	P	2.2	A4	8.8	Y	+15	+15	9612	67	29.99	59	3	88.0	3U	3500	0.3												
															2	89.0	3U	3600	0.3												
															4	85.0	3U	3000	0.3												
26-03	C	F	N	P	2.2	A4	8.8	Y	+15	+15	9790	70	30.00	61	3	85.0	3U	3150	0.3	F											
															2	85.0	4U	2500	0.3												
															4	83.0	4U	2500	0.3												
41-21	C	C	N	P	2.2	A4	8.8	Y	+15	+15	6165	72	30.24	47	3	85.0	4U	2450	0.6	F				N			N				
															2	89.0	3U	3250	0.5												
															4	85.0	3U	4200	0.5												
29-16	C	F	N	P	2.2	A4	8.8	Y	+15	+15	15191	70	29.59	55	3	86.0	3U	3200	0.5	86.0	3U	2700	2.0								
															2	87.0	3U	3500	0.5												
															4	85.0	2U	2700	0.5												
65-10	C	F	N	P	2.2	A4	8.8	Y	+15	+15	8375	80	29.60	100	3	89.0	4L	2500	0.0	F											
															2	92.0	3U	2600	0.0												
															4	86.5	4L	2500	0.0												
05-04	C	F	N	P	2.2	M5	8.8	Y			7652	70	30.05	50	3	86.0	3	3010	0.3	86.0	3	4000	1.5	N	92.0	82.7	N				
															2	88.0	2	3100	0.2												
															4	84.0	3	3160	0.3												
41-22	C	C	N	P	2.2	A4	8.8	Y	+15	+15	11917	82	30.00	38	3	81.0	3U	2900	0.6	L				N			N				
															2	82.0	4U	2800	0.7												
															4	81.0	2U	3150	0.6												
26-27	C	F	N	P	2.2	M5	8.6	Y	+0	+6	15488	81	29.90	121	3	90.0	3	2750	0.5					N			N				
															2	91.0	3	1950	0.5												
															4	90.0	4	1700	0.5												
06-17	C	F	N	P	2.2	A4	8.6	Y	-6	-6	8386	83	30.14	101	3	83.0	4U	1600	0.6	L				N	93.2	82.6	N				
															2	85.0	3U	2600	0.4												
															4	81.0	3U	2800	0.4												
05-06	C	F	Y	P	2.2	A4	9.5	Y			9987	69	30.06	50	3	86.0	3U	3750	0.8	87.0	4L	2000	3.0	N	92.3	82.4	N				
															2	87.0	4L	1800	0.8												
															4	86.0	3U	2900	0.8												

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OBS. NO.	VEHICLE DESCRIPTION: YEAR	MAKE	CID	FUEL SYS	DRIVE	TRANS	A/C	SPARK ADVANCE: AS RCD	AS TST	ODOM MILES	WEATHER: AMB TMP	BAROM	HUM	OCTANE NUMBER REQUIREMENT DATA: FUEL	MAXIMUM: OCT NO	GEAR	RPM	VAC	PART-THROTTLE: OCT NO	GEAR	RPM	VAC	TANK FUEL INFORMATION: OXY	OCT NO RES	OCT NO MOTR	OXY TYPE	RATER: TYPE	GEAR	RPM	VAC
41-26	C	F	N	P	2.2	M5	9.5	Y	+10	+10	7546	72	29.87	25	3	81.0	4	3100	0.2	L				N			N			
															2	84.0	4	3000	0.2											
															4	82.0	4	2800	0.2											
08-05	C	F	N	P	2.2	A4	9.5	Y	+10	+10	8684	78	29.66	36	3	86.0	3U	2400	0.8	86.0	3U	2050	3.0							
															2	87.0	3U	2400	0.8	86.0	3U	2100	3.0							
															4	86.0	3U	2400	0.8											
05-16	C	F	N	P	2.3	A3	9.0	Y	+15	+15	6228	70	30.30	45	3	92.0	3	2700	0.5					N	92.0	82.1	B	M	3	3100	0.5
															2	94.0	3	2850	0.5											
															4	90.0	2	3000	0.5											
28-27	C	F	N	P	2.3	A3	9.0	Y	+15	+15	12302	70	29.27	50	3	93.0	2	3600	0.5	92.0	2	3600	1.5							
															2	96.0	2	3400	0.5											
															4	91.0	2	3300	0.5											
32-04	C	F	N	P	2.3	A3	9.0	Y	+15	+15	17061	70	29.38	50	3	87.0	3	2700	0.5	87.0	3	3100	2.0							
															2	88.0	3	2700	0.5	88.0	3	3200	2.0							
															4	87.0	3	2900	0.5	87.0	3	3000	2.0							
32-10	C	F	N	P	2.3	A3	9.0	Y	+15	+15	33048	70	29.54	50	3	89.0	3	3200	0.5	89.0	3	3200	2.0	N	92.2	83.3	N			
															2	90.0	3	3100	0.5	90.0	3	3200	2.0							
															4	88.0	3	3000	0.5	88.0	3	3000	2.0							
41-02	C	C	N	P	2.3	A3	9.0	Y	+15	+15	14005	72	30.00	55	3	86.0	3	2200	2.0	F										
															2	87.0	3	2000	2.0											
															4	85.0	3	2050	2.0											
65-03	C	F	N	P	2.3	A3	9.0	Y	+15	+15	6000	72	29.70	76	3	90.0	3	2750	0.5	89.5	2	3400	2.0							
															2	92.5	3	2800	1.0											
															4	88.0	3	2800	0.5											
07-20	C	F	N	P	2.3	A3	9.0	Y	+15	+15	9881	70	29.98	52	3	93.0	2	3800	0.0					O			A	M	3	3000	0.0
															2	94.0	2	3800	0.0											
															4	89.0	3	3000	0.0											
05-02	C	F	Y	P	2.3	M5	10.0	Y			9260	70	30.02	50	3	86.0	4	1800	0.0	F				N	98.4	87.6	N			
															2	87.0	4	1710	0.0											
															4	82.0	4	1520	0.0											
40-02	C	F	Y	P	2.3	A3	9.5	Y			15138	68	29.94	77	3	88.0	2U	2600	0.0	88.0	2U	2700	1.5							
															2	88.0	3U	2900	0.0	89.0	3L	2250	2.0							
															4	88.0	2U	2650	0.0	88.0	2U	2750	2.0							

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

OBS. NO.	TYPE	EMCT	KS	F/A SYS	DSP	TRANS	C.R.	AIR	SPARK ADVANCE AS RCD	SPARK ADVANCE AS TST	ODOM MILES	AMB TMP	BAROM	HUM	FUEL	MAXIMUM OCT NO	MAXIMUM GEAR	MAXIMUM RPM	MAXIMUM VAC	PART-THROTTLE OCT NO	PART-THROTTLE GEAR	PART-THROTTLE RPM	PART-THROTTLE VAC	OWKNK	OCT NO RES	OCT NO MOTR	KNINT	THR	RATER GEAR	RATER RPM	RATER VAC
05-07	C	F	Y	P	2.3	M5	10.0	Y			11382	70	30.10	50	3	91.0	4	3000	0.2	90.5	3	4760	1.5								
															2	93.0	4	3050	0.2												
															4	87.0	4	2820	0.2												
65-21	C	F	Y	P	2.3	M5	10.0	Y			7750	66	29.40	42	3	91.5	4	3300	0.0	91.5	4	3300	1.5	N	95.9	86.3	N				
															2	92.5	4	3300	0.0												
															4	88.5	4	3300	0.0												
28-14	C	F	Y	P	2.3	M5	10.0	Y			9803	70	29.37	50	3	85.0	4	1800	0.5	83.0	4	1100	1.5								
															2	85.0	4	2000	0.5												
															4	85.0	4	2000	0.5												
28-08	C	F	Y	P	2.3	A3	9.5	Y			10263	70	29.28	50	3	85.0	2U	2300	0.7	83.0	2U	2250	1.5								
															2	86.0	2U	2300	0.7												
															4	85.0	2U	2400	0.7												
41-10	C	C	N	P	2.3	A4	9.8	Y			8352	75	30.06	36	3	92.0	2U	2400	0.5												
															2	93.0	2U	2200	0.5												
															4	90.0	2U	2200	0.5												
26-28	C	F	N	P	2.4	A4	8.5	Y	+ 5	+ 5	12142	85	30.08	140	3	94.0	3U	2300	0.5	F											
															2	94.0	2U	2400	0.5												
															4	90.0	3U	2400	0.5												
26-30	C	F	N	P	2.4	A4	8.5	Y			10854	73	30.20	52	3	90.0	4L	2500	0.5												
															2	91.0	4U	2300	0.5												
															4	89.0	4U	2500	0.5												
28-11	C	F	N	P	2.4	A4	8.6	Y	+15	+15	10467	70	29.38	50	3	84.0	3L	2300	1.5	83.0	2U	2300	1.5								
															2	86.0	3L	2300	1.5												
															4	84.0	3L	2300	1.0												
47-07	C	C	N	P	2.4	A4	8.6	Y	+15	+15	7400	70	29.92	62	3	92.0	3L	2400	1.0	89.0	3L	2400	2.0								
															2	94.0	3L	2500	1.0												
															4	91.0	3L	2300	1.0												
62-02	C	F	N	P	2.4	A4	8.6	Y	+15	+15	11329	76	29.58	52	3	89.0	3U	2900	0.6	F											
															2	89.0	4U	2300	1.2												
															4																
07-10	C	F	N	P	2.4	A4	8.6	Y	+15	+15	10530	73	30.74	48	3	87.0	4U	2500	0.0					N			N				
															2	88.0	4U	2500	0.0												
															4	85.0	3U	2900	0.0												

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

	VEHICLE DESCRIPTION										WEATHER			OCTANE NUMBER REQUIREMENT DATA								TANK FUEL INFORMATION					
															MAXIMUM				PART-THROTTLE						RATER	
OSS. NO.	TYPE	F/A	TRANS	SPARK ADVANCE										FUEL	OCT NO	GEAR	RPM	VAC	OCT NO	GEAR	RPM	VAC	OWK	OCT NO RES	OCT NO MOTR	KNIT	GEAR
	PC	TK	S	DSP	S	C.R.	IR	AS RCD	AS TST	ODOM MILES	AMB TMP	BAROM	HUM	E									K				
41-20	C	F	M	P	2.4	M5	8.6	Y	+15	+15	8049	65	30.28	52	3	82.0	4U	2300	0.4	82.0	4U	2400	2.0	N			N	
															2	83.0	4U	2350	0.4	83.0	3U	2200	3.0					
															4	82.0	3U	2100	0.5									
62-04	C	F	N	P	2.4	A4	8.6	Y	+12	+15	13521	68	29.84	38	3	L				L								
															2	80.0	3	2400	1.8	L								
															4													
26-29	C	F	N	T	2.5	M5	8.9	Y			11694	73	30.04	85	3	84.0	4	1300	0.5									
															2	87.0	4	3400	0.5									
															4	86.0	4	1300	0.5	87.0	4	1300	1.5					
08-18	C	A	N	T	2.5	A3	8.9	Y	+12	+12	6737	76	29.43	48	3	88.0	3U	2500	1.0	86.0	3U	2350	3.0					
															2	89.0	3U	2500	1.0									
															4	86.0	3U	2450	1.0									
07-17	C	F	N	T	2.5	M5	8.9	Y	+ 5	+ 5	6968	73	30.15	75	3	82.0	4	2000	0.0					N			N	
															2	85.0	4	2000	0.0									
															4	82.0	4	2100	0.0									
06-23	C	F	N	T	2.5	A3	8.9	Y			9067	83	29.95	64	3	83.0	3L	1600	1.0	82.0	3L	1700	1.4	N				
															2	86.0	3L	1850	1.0									
															4	82.0	2U	2000	1.0									
28-01	C	F	N	T	2.5	A3	8.9	Y	+12	+12	9570	70	29.30	50	3	86.0	2U	2200	0.7	84.0	2U	2300	1.7					
															2	87.0	2U	2200	0.7									
															4	86.0	2U	2200	0.7									
46-12	C	E	N	T	2.5	A3	8.9	Y	+12	+12	9257	70	29.44	62	3	84.0	3L	2100	1.0	83.0	3L	2025	2.0	N	91.5	82.8		
															2	87.0	3U	2300	1.0									
															4	84.0	3L	2150	1.0									
65-01	C	F	N	T	2.5	A3	8.9	Y	+12	+12	9630	68	29.70	64	3	85.0	2U	1500	0.5	82.0	3L	1900	1.5					
															2	85.5	2U	1500	0.5									
															4	84.5	2U	1500	0.5									
29-05	C	F	Y	TP	2.5	A3	7.8	Y	+12	+12	9369	70	29.59	55	3	91.5	3U	2800	-11.0	88.0	3U	3000	-5.0					
															2	94.5	3U	2800	-11.0									
															4	93.0	3U	2800	-11.0									
29-19	C	F	Y	TP	2.5	A3	7.8	Y	+12	+12	9415	70	29.42	55	3	91.0	3	2750	-5.0	90.0	3	2900	0.0					
															2	91.0	3	2700	-5.0									
															4	90.5	2	2550	-11.0									

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

	VEHICLE DESCRIPTION										WEATHER				OCTANE NUMBER REQUIREMENT DATA								TANK FUEL INFORMATION								
																MAXIMUM				PART-THROTTLE						RATER			
							SPARK ADVANCE																							
OBS. NO.	TYPE	EMCK TS	F/A S	TRANS	DSP	C.R.	AIR	AS RCD	AS TST	ODOM MILES	AMB TMP	BAROM	HUM	FUEL	OCT NO	GEAR	RPM	VAC	OCT NO	GEAR	RPM	VAC	OWK N	OCT NO RES	OCT NO MOTR	KNIT N	GTE HAR	RPM	VAC	
25-03	C	E N	T	2.5	A3	8.9	Y	+12	+12	13661	86	29.52	98	3	88.0	3L	2300	1.3	86.0	3U	2400	2.2	N	91.2	82.8	N				
														2	89.0	3L	2400	1.3											
														4	85.0	3U	2300	1.3											
40-01	C	F N	T	2.5	A3	8.9	Y	+12	+12	10322	82	29.85	99	3	88.5	3U	2400	0.0	89.0	2U	2500	2.5								
														2	89.5	3U	2750	0:0	89.0	3U	2750	2.5								
														4	87.0	3L	2750	0.0	87.0	3L	2750	2.0								
08-03	C	F N	T	2.5	A3	8.3	Y			13763	77	29.80	34	3	85.0	3U	3000	0.5	F											
														2	87.0	2U	3400	0.8											
														4	84.0	2U	3400	0.8											
08-16	C	F N	T	2.5	A3	8.3	Y			17242	76	29.90	65	3	87.0	3U	3150	0.6	84.0	3U	2550	4.0								
														2	88.0	2U	3100	0.5											
														4	83.0	2U	3100	0.5											
05-01	C	F N	T	2.5	A3	9.0	Y			9289	70	29.98	50	3					99.0	3L	2400	6.0	Y			A	P	3L	2100	6.0
														2					102.0	3L	2100	6.0								
														4	85.5	3U	2300	0.6											
24-03	C	F N	T	2.5	A3	8.3	Y			14487	42	29.76	61	3	92.0	3U	2700	1.4	F											
														2	92.0	3U	2600	1.4											
														4	86.0	3U	2700	1.4											
41-09	C	C N	T	2.5	A3	9.0	Y			7656	69	29.92	72	3	95.0	3L	2850	0.8	95.0	3U	2350	2.4								
														2	96.0	3L	2700	0.8	96.0	3U	2400	3.0								
														4	94.0	3U	2650	1.0											
47-01	C	C N	T	2.5	A3	9.0	Y			10660	70	29.98	62	3	89.0	3U	3000	0.6	102.0	3L	2000	10.0								
														2					104.0	3L	2000	10.0								
														4	87.0	3U	2900	0.6											
65-25	C	F N	P	2.5	M5	8.8	Y			6900	75	29.50	54	3	89.0	4	2000	0.0	88.0	4	2500	3.0								
														2	90.0	3	4000	0.0											
														4	89.0	3	2000	0.0											
06-16	C	F Y	P	2.5	A4	9.0	Y	-10	-10	9525	76	29.90	80	3	90.0	2U	2600	0.4					N	97.2	85.6	N				
														2	92.0	2U	2475	0.4											
														4	87.0	2U	2400	0.4											
29-01	C	F Y	P	2.5	A4	9.0	Y	+10	+10	9569	70	30.41	55	3	96.5	2U	2600	0.1	F											
														2	98.0	2U	2400	0.1											
														4	93.0	2U	2400	0.1											

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

	VEHICLE DESCRIPTION										WEATHER			OCTANE NUMBER REQUIREMENT DATA								TANK FUEL INFORMATION							
															MAXIMUM				PART-THROTTLE							RATER			
					T		SPARK							F		G			G			O		K				
		E		F/A	R		ADVANCE							U		E			E			W		N	G			
	Y	M		S	A		A	-------						E	OCT	A			OCT	A		K	OCT	NO	I	T	E		
OBS.	P	C	K	Y	N		I	AS	AS	ODOM	AMB			L	NO	R	RPM	VAC	NO	R	RPM	VAC	N	----------		N	H	A		
NO.	E	T	S	S	DSP	S	C.R.	R	RCD	TST	MILES	TMP	BAROM	HUM									K	RES	MOTR	T	R	R	RPM	VAC
29-02	C	F	Y	P	2.5	A4	9.0	Y	+10	+10	10016	70	30.41	55	3	94.5	2	2700	1.0	F										
															2	94.5	2	2800	1.0										
															4	91.0	2	2400	1.0										
05-12	C	F	N	P	2.7	A4	9.0	Y	+15	+15	10320	68	30.00	52	3	92.0	3U	2850	0.5				N	91.9	82.2	B	M	3L	2700	0.5
															2	94.0	3U	2600	0.5										
															4	90.0	3U	2550	0.5										
47-20	C	C	N	P	2.7	A4	9.0	Y	+15	+15	6560	70	29.95	54	3	91.0	4L	2500	0.2	88.0	4L	2500	1.2							
															2	91.0	4L	2500	0.2										
															4	90.0	4L	2000	0.2										
26-18	C	F	N	P	3.0	A4	8.9	Y	+12	+12	22254	95	30.02	124	3	90.0	3U	2550	0.5	90.0	3U	2450	2.0	N			N			
															2	92.0	3U	2600	0.5										
															4	89.0	3U	2550	0.5										
40-03	C	F	N	P	3.0	A4	8.9	Y	+12	+12	19541	88	29.79	99	3	89.0	2U		0.0	86.0	3U		3.0							
															2	89.0	3U		0.0	89.0	3U		3.0							
															4	86.0	4U		0.0										
26-07	C	F	N	P	3.0	A4	8.9	Y	+12	+12	9213	70	29.98	61	3	85.0	2U	2700	0.5	F										
															2	86.0	3U	2800	0.5										
															4	83.0	3U	2750	0.5										
26-14	C	F	N	P	3.0	A4	8.9	Y	+12	+12	10700	92	29.98	110	3	85.0	3U	2500	0.5	85.0	3U	2550	1.5							
															2	86.0	3U	2500	0.5										
															4	85.0	2U	2350	0.5										
41-14	C	C	N	P	3.0	A4	8.9	Y	+ 5	+12	29716	81	29.88	38	3	90.0	3U	2500	2.0	F										
															2	91.0	3U	2500	2.0										
															4	88.0	4L	1900	1.2										
46-01	C	E	N	P	3.0	A4	8.9	Y	+12	+12	18807	70	29.30	90	3	82.5	3U	1800	1.0	L			N	91.5	82.9	N			
															2	84.5	3U	2125	1.0										
															4	80.0	3U	2400	1.0										
07-13	C	F	N	P	3.0	A4	8.9	Y	+12	+12	21145	70		0	3	82.0	4L	2300	0.0											
															2	85.0	3U	3050	0.0										
															4	82.0	4L	2100	0.0										
25-10	C	E	N	P	3.0	A4	8.9	Y	+12	+12	9237	71	29.57	38	3	84.0	3U	2500	1.3	83.0	3U	2500	2.2	N	92.2	82.9	N			
															2	85.0	3U	2600	1.3										
															4	83.0	3U	2500	1.8										

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

OBS. NO.	VEHICLE DESCRIPTION: TYPE	EMCT	KS	F/A SYS	DSP	TRANS	C.R.	AIR	SPARK ADVANCE: AS RCD	AS TST	ODOM MILES	WEATHER: AMB TMP	BAROM	HUM	FUEL	OCTANE NUMBER REQUIREMENT DATA: MAXIMUM: OCT NO	GEAR	RPM	VAC	PART-THROTTLE: OCT NO	GEAR	RPM	VAC	TANK FUEL INFORMATION: OWKNK	OCT NO: RES	MOTR	KNINT	RATER: THR	GEAR	RPM	VAC
25-01	C	E	N	P	3.0	A4	9.3	Y			11499	81	29.47	155	3	89.0	4L	1800	0.8												
															2	90.0	2U	4500	0.8												
															4	87.0	2U	2400	0.8												
05-27	C	F	Y	P	3.0	A4	8.9	Y	+12	+12	6573	70	30.10	52	3	87.0	2U	2300	0.5					N	92.7	81.9	N				
															2	88.0	3U	2450	0.5												
															4	86.0	2U	2400	0.5												
46-06	C	E	Y	P	3.0	A4	8.9	Y	+12	+12	16657	72	29.48	90	3	85.0	3U	2500	1.0	F				N	91.2	83.3					
															2	87.0	3U	2850	1.0												
															4	83.0	3U	2400	1.0												
65-28	C	F	Y	P	3.0	A4	8.9	Y	+12	+12	6100	75	29.70	32	3	84.0	3U	3100	1.5	L											
															2	86.0	3U	2600	1.5												
															4	82.0	3U	2400	1.5												
32-08	C	F	N	P	3.0	M5	9.3	Y	+10	+10	13378	70	29.56	50	3	85.0	4	1500	0.3	85.0	4	1400	4.0	N	92.0	82.8	N				
															2	86.0	4	1700	0.4	86.0	4	1600	4.0								
															4	85.0	4	1500	0.3	85.0	4	1400	4.0								
05-08	C	F	Y	P	3.0	A4	9.3	Y	+10	+10	9715	70	30.10	50	3	92.0	4L	1800	1.0	F											
															2	92.0	4L	1480	1.5												
															4	87.5	2U	1700	0.5												
06-07	C	F	Y	P	3.0	A4	9.3	Y	-10	-10	20050	67	30.15	75	3	86.0	4U	1900	0.4	85.0	4U	1900	4.0	N	91.3	82.0	N				
															2	86.0	4U	1800	0.4	86.0	4U	3300	4.0								
															4	86.0	4U	1800	0.4												
28-28	C	F	Y	P	3.0	A4	9.3	Y	+10	+10	8925	70	29.60	50	3	92.0	4U	1400	3.0	91.0	4L	1500	2.7								
															2	92.0	4U	1500	3.0												
															4	90.0	4L	1400	1.7												
46-21	C	E	Y	P	3.0	A4	9.3	Y	+10		14000	74	29.38	5	3	88.0	3U	3100	1.0	F				N							
															2	89.0	3U	1850	1.0												
															4	86.0	3U	1850	1.0												
29-24	C	F	Y	P	3.0	A4	9.3	Y	+10	+10	9369	70	29.52	55	3	93.0	4L	1600	1.0	93.0	4L	1450	2.0								
															2	94.0	2U	2900	0.6												
															4	92.0	4L	1600	1.0												
29-25	C	F	Y	P	3.0	A4	9.3	Y	+10	+10	14710	70	29.52	55	3	92.0	4L	1700	0.8	92.0	4L	1750	2.0								
															2	93.0	3L	1300	0.8												
															4	91.0	4L	1600	0.8												

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

	VEHICLE DESCRIPTION										WEATHER			OCTANE NUMBER REQUIREMENT DATA								TANK FUEL INFORMATION						
															MAXIMUM				PART-THROTTLE					RATER			
OBS. NO.	TYPE	EM	CK	F/AS	DSP	TRANS	C.R.	SPARK ADVANCE AIR	SPARK ADVANCE RCD	SPARK ADVANCE TST	ODOM MILES	AMB TMP	BAROM	HUM	FUEL	OCT NO	GEAR	RPM	VAC	OCT NO	GEAR	RPM	VAC	OWK OCT NO RES	OWK OCT NO MOTR	KNI TH	GTE AR	RPM	VAC
47-03	C	C	Y	P	3.0	A4	9.3	Y	+10	+10	11400	70	29.98	57	3	92.0	4L	2300	0.4	F								
															2	92.0	4L	2500	0.4									
															4	92.0	4L	2000	0.4									
65-06	C	F	Y	P	3.0	A4	9.3	Y	+10	+10	12375	77	29.60	0	3					93.0	4L	1650	3.0						
															2					95.0	4L	1700	3.0						
															4					90.0	4L	1600	3.0						
07-01	C	F	Y	P	3.0	A4	9.3	Y	+10	+10	20001	72	30.35	58	3	93.0	2U	3500	0.0									
															2	94.0	2U	3700	0.0									
															4	92.0	4L	1900	0.0									
07-02	C	F	Y	P	3.0	A4	9.3	Y	+10	+10	6310	77	30.23	0	3	88.0	4L	2100	0.0									
															2	88.0	4L	2100	0.0									
															4	86.0	4L	2100	0.0									
28-25	C	F	Y	P	3.0	M5	9.8	Y			10352	70	29.27	50	3	89.0	3	1400	0.5	87.0	4	1600	5.0						
															2	91.0	3	1400	0.5									
															4	88.0	3	1400	0.5									
40-13	C	F	Y	P	3.0	M5	9.8	Y			8286	80	29.85	101	3	94.0	4	2000	0.0	93.0	4	2000	2.0						
															2	94.0	4	1800	0.0									
															4	95.0	4	1900	0.0									
28-21	C	F	Y	P	3.0	A4	9.0	Y	+15	+15	14835	70	29.38	50	3	85.0	2U	2500	0.5	83.0	3U	1500	1.7						
															2	87.0	2U	2500	0.5									
															4	85.0	2U	2600	0.5									
65-07	C	F	Y	P	3.0	A4	9.0	Y	+15	+15	8100	83	29.20	130	3	85.5	2U	2000	0.0	83.0	4U	2000	2.5						
															2	86.5	2U	2000	0.0									
															4	83.0	2U	2000	0.0									
62-03	C	F	Y	P	3.0	A4	9.0	Y	+15	+15	15990	72	29.59	62	3	84.0	3U	2700	1.0	82.0	3U	2100	3.0						
															2	85.0	3U	2700	1.0									
															4														
07-07	C	F	Y	P	3.0	A4	9.0	Y	+35	+35	13971	78	29.74	50	3	87.0	3U	2900	3.0					N		N			
															2	84.0	3U	2900	3.0									
															4	82.0	3U	2700	3.0									
62-05	C	F	Y	P	3.0	A4	10.5	Y	+15	+15	8112	84	29.31	62	3	L				L									
															2	L				L									
															4														

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

	VEHICLE DESCRIPTION										WEATHER				OCTANE NUMBER REQUIREMENT DATA								TANK FUEL INFORMATION							
									SPARK ADVANCE						MAXIMUM				PART-THROTTLE							RATER				
OBS. NO.	TYPE	EMCT	KS	F/A SYS	DSP	TRANS	C.R.	AIR	AS RCD	AS TST	ODOM MILES	AMB TMP	BAROM	HUM	FUEL	OCT NO	GEAR	RPM	VAC	OCT NO	GEAR	RPM	VAC	OWKNK	OCT NO RES	OCT NO MOTR	KNINT	THR	GEAR	RPM	VAC
47-25	C	C	Y	P	3.1	A4	8.8	Y			6790	70	30.25	50	3	96.0	4L	1650	0.5	F											
															2	96.0	4L	1650	0.5												
															4	96.0	4L	1650	0.5												
07-05	C	F	Y	P	3.1	A4	8.8	Y			10012	70	30.30	0	3	88.0	4U	2700	0.0												
															2	87.0	4U	2700	0.0												
															4	86.0	4U	2900	0.0												
07-06	C	F	Y	P	3.1	A4	8.8	Y			10005	70	30.32	0	3	88.0	4L	2050	0.0												
															2	88.0	4L	2100	0.0												
															4	85.0	4L	2050	0.0												
06-01	C	F	Y	P	3.1	A3	8.8	Y			7437	82	29.81	85	3	82.0	2U	3000	1.0	L				N	98.6	88.3	N				
															2	88.5	2U	3000	1.0												
															4	78.0	2U	3000	1.0												
26-04	C	F	Y	P	3.1	A3	8.8	Y			6704	68	29.95	64	3	85.0	3U	2700	0.5	F											
															2	86.0	3U	2700	0.5												
															4	85.0	2U	1175	0.5												
40-10	C	F	Y	P	3.1	A3	8.8	Y			8736	83	29.94	86	3	96.0	3U		0.0	95.0	3U		7.0								
															2	98.0	3L		0.0												
															4	94.0	3L		0.0												
29-03	C	F	Y	P	3.1	A3	8.8	Y			9456	70	30.46	55	3	87.5	3U	2200	2.2	87.5	3U	2600	3.5								
															2	93.0	3U	2200	2.2												
															4	85.0	3U	2300	2.2												
29-06	C	F	Y	P	3.1	A3	8.8	Y			9882	70	29.59	55	3	92.0	3L	2100	2.0	92.0	3L	1950	3.5								
															2	95.0	3L	2000	2.0												
															4	84.5	3U	2300	2.0												
47-24	C	C	Y	P	3.1	A3	8.8	Y			7350	70	29.97	58	3	94.0	3U	2600	1.0	90.0	3U	2500	1.5								
															2	95.5	3U	2500	1.0												
															4	90.0	3L	2100	1.5												
08-02	C	F	Y	P	3.1	A3	8.8	Y			24701	78	29.97	48	3	87.0	3U	2500	2.5	85.0	3U	2150	7.0								
															2	88.0	3U	2550	2.5	88.0	3U	2150	7.0								
															4	84.0	3U	2500	2.5												
08-07	C	F	Y	P	3.1	A3	8.8	Y			7729	74	29.91	53	3	87.0	3U	2350	1.7	87.0	3U	2100	4.0								
															2	89.0	3U	2350	1.7	89.0	3U	2150	4.0								
															4	86.0	3U	2200	1.7												

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

VEHICLE DESCRIPTION (OBS. NO. through AIR, SPARK ADVANCE) — WEATHER (ODOM MILES through HUM) — OCTANE NUMBER REQUIREMENT DATA (FUEL, MAXIMUM, PART-THROTTLE) — TANK FUEL INFORMATION (OWNK, OCT NO, RATER)

OBS. NO.	TYPE	EMCT	KS	F/A SYS	DSP	TRANS	C.R.	AIR	SPARK ADVANCE AS RCD	SPARK ADVANCE AS TST	ODOM MILES	AMB TMP	BAROM	HUM	FUEL	MAXIMUM OCT NO	MAXIMUM GEAR	MAXIMUM RPM	MAXIMUM VAC	PART-THROTTLE OCT NO	PART-THROTTLE GEAR	PART-THROTTLE RPM	PART-THROTTLE VAC	OWNK	OCT NO RES	OCT NO MOTR	RATER KNINT	RATER THR	RATER GEAR	RATER RPM	RATER VAC
28-24	C	F	Y	P	3.1	A3	8.8	Y			9848	70	29.33	50	3	86.0	2U	1900	1.3	85.0	2U	1900	3.0								
															2	86.0	3U	1900	2.7												
															4	84.0	2U	1900	1.3												
40-14	C	F	Y	P	3.1	A3	8.8	Y			14210	73	29.66	63	3	96.0	3U		0.0	95.0	3U		3.0								
															2	97.0	3U		0.0												
															4	91.0	3U		0.0	91.0	3U		2.0								
47-05	C	F	Y	P	3.1	A3	8.8	Y			24100	70	29.95	70	3	99.0	3L	2200	1.8	96.0	3L	2100	3.5								
															2	99.0	3L	2300	1.8												
															4	88.0	3L	2000	1.8												
65-16	C	F	Y	P	3.1	A3	8.8	Y			10100	73	29.60	66	3	92.0	3U	2200	2.0	91.0	2U	2100	2.0								
															2					94.0	2U	2100	2.0								
															4					85.0	2U	2200	3.0								
24-01	C	F	Y	P	3.1	A4	8.8	Y			16221	42	29.72	66	3	88.0	3U	2650	1.0	88.0	3U	2400	3.5								
															2	89.0	3L	2150	0.8	90.0	3L	2100	3.0								
															4	86.0	3U	2600	1.0	86.0	3U	2400	3.5								
28-04	C	F	Y	P	3.1	A4	8.8	Y			10105	70	29.38	50	3	91.0	4L	1550	1.0	90.0	4L	1550	2.0								
															2	92.0	4L	1600	1.0	92.0	4L	1550	2.0								
															4	88.0	4L	1550	1.0												
41-29	C	C	Y	P	3.1	A4	8.8	Y			8385	74	29.94	53	3	86.0	4L	1700	1.0	F											
															2	86.0	4L	1650	1.0												
															4	82.0	4L	1750	1.0												
28-29	C	F	Y	P	3.1	A3	8.8	Y			11876	70	28.85	50	3	83.0	2U	2500	0.7	85.0	2U	2200	2.0								
															2	85.0	2U	2600	0.7	87.0	2U	2200	2.0								
															4	83.0	2U	2500	0.7												
06-14	C	F	Y	P	3.1	A4	8.8	Y	-15-	-15	9625	76	30.18	106	3	81.0	4L	1850	1.4	L				N			N				
															2	81.0	4L		1.4												
															4	77.0	4L		1.4												
26-08	C	F	Y	P	3.1	A4	8.8	Y			8989	70	29.96	61	3	84.0	4L	1450	0.5	F											
															2	84.0	4L	1425	0.5												
															4	83.0	4L	1500	0.5												
26-10	C	F	Y	P	3.1	A4	8.8	Y			11139	93	30.05	90	3	92.0	4L	1600	0.5	91.0	4L	1650	2.0								
															2	93.0	4L	1575	0.5												
															4	90.0	4L	1550	0.5												

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OBS. NO.	VEHICLE DESCRIPTION: TYPE	EM	CK	F/A SYS	DSP	TRANS	C.R.	SPARK ADVANCE: AIR	AS RCD	AS TST	WEATHER: ODOM MILES	AMB TMP	BAROM	HUM	FUEL	MAXIMUM: OCT NO	GEAR	RPM	VAC	PART-THROTTLE: OCT NO	GEAR	RPM	VAC	TANK FUEL INFORMATION: OWNK	RATER: OCT NO RES	RATER: OCT NO MOTR	KNIT	GEAR	RPM	VAC
26-11	C	F	Y	P	3.1	A4	8.8	Y			10640	96	30.00	103	3	90.0	4L	1550	0.5	90.0	4L	1500	1.5						
															2	91.0	4L	1500	0.5										
															4	90.0	4L	1500	0.5										
26-12	C	F	Y	P	3.1	A4	8.8	Y			10697	95	30.03	95	3	92.0	4L	1500	0.5	92.0	4L	1500	1.5						
															2	93.0	4L	1450	0.5										
															4	93.0	4L	1500	0.5										
65-09	C	F	Y	P	3.1	A4	8.8	Y			6000	75	29.50	72	3	83.0	4L	1600	0.0	83.0	4L	1600	2.0						
															2	81.0	4L	1600	0.0										
															4	81.0	4L	1600	0.0										
05-11	C	F	Y	P	3.1	A4	8.8	Y			7866	70	30.10	44	3	85.0	4L	1500	1.0					N	92.2	82.0	N			
															2	87.0	3L	1850	1.5										
															4	84.0	3L	1900	1.5										
08-21	C	F	Y	P	3.1	A4	8.8	Y			7435	79	29.82	61	3	84.0	4L	1425	1.0	80.0	3U	2350	5.0						
															2	85.0	4L	1500	1.0	84.0	3U	2400	5.0						
															4	82.0	4L	1425	1.0										
41-11	C	C	Y	P	3.1	A4	8.8	Y			8815	62	30.04	31	3	84.0	4L	1800	1.0	F									
															2	84.0	4L	1750	1.0										
															4	81.0	4L	1900	1.0										
46-03	C	E	Y	P	3.1	A4	8.8	Y			12294	71	29.35	81	3	87.0	3U	1950	1.0	F				N			N		
															2	88.0	3U	2475	1.0										
															4	84.0	3U	2750	1.0										
40-07	C	F	Y	P	3.3	A4	8.9	Y			8707	81	29.84	60	3	87.0	3U	3400	0.0	F									
															2	88.0	3U	2700	0.0										
															4	85.0	3U	3300	0.0										
65-29	C	F	Y	P	3.3	A4	8.9	Y	--		8750	70	29.20	63	3	80.0	2U	2800	0.5	L									
															2	80.0	2U	2500	0.5										
															4	78.0	2U	3000	0.5										
28-05	C	F	Y	P	3.3	A4	8.9	Y			10408	70	29.35	50	3	L				L									
															2	81.0	4U	1700	2.5										
															4	79.0	2U	1400	1.0										
41-01	C	C	Y	P	3.3	A4	8.9	Y			10378	70	29.94	36	3	95.0	4U	1850	1.5	F									
															2	96.0	4U	2000	1.5										
															4	94.0	4U	1800	1.5										

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	VEHICLE DESCRIPTION										WEATHER				OCTANE NUMBER REQUIREMENT DATA									TANK FUEL INFORMATION							
									SPARK ADVANCE							MAXIMUM				PART-THROTTLE							RATER				
OBS. NO.	TYPE	EMCT	KS	F/A SYS	DSP	TRANS	C.R.	AIR	AS RCD	AS TST	ODOM MILES	AMB TMP	BAROM	HUM	FUEL	OCT NO	GEAR	RPM	VAC	OCT NO	GEAR	RPM	VAC	OWKNK	OCT NO RES	OCT NO MOTR	KNIT	THR	GEAR	RPM	VAC
47-13	C	C	Y	P	3.3	A4	8.9	Y			10300	70	30.00	54	3	L				L											
															2	L															
															4	L															
65-13	C	F	Y	P	3.3	A4	8.9	Y			10000	70	29.80	71	3	L				L											
															2	L															
															4	L															
08-20	C	F	Y	P	3.3	A3	9.0	Y			14646	80	29.86	29	3	L				80.0	3U	1800	6.0								
															2	L				85.0	3U	1800	6.0								
															4	76.0	3U	1850	1.8	78.0	3U	1800	6.0								
08-22	C	F	Y	P	3.3	A3	9.0	Y			15184	78	29.61	53	3	82.0	3L	1500	1.6	80.0	3U	1850	4.0								
															2	82.0	3L	1500	1.6	82.0	3U	1900	4.0								
															4	80.0	3L	1800	1.6												
08-27	C	F	Y	P	3.3	A3	9.0	Y			14753	80	30.02	37	3	80.0	3L	1350	1.5	80.0			0.0								
															2	80.0	3L	1400	1.5	80.0	3L	1325	3.5								
															4	76.0	3U	1950	2.5												
08-29	C	F	Y	P	3.3	A3	9.0	Y			19275	76	30.07	27	3	80.0	3L	1450	1.7	80.0	3U	1750	7.0								
															2	80.0	3L	1450	1.7	82.0	3U	1750	7.0								
															4	78.0	3L	1600	1.7	76.0	3U	1800	7.0								
26-13	C	F	Y	P	3.3	A3	9.0	Y			10850	88	30.03	129	3	89.0	3L	1400	1.0	89.0	3L	1400	2.0								
															2	89.0	3U	1750	1.0												
															4	89.0	3U	1850	1.0												
41-05	C	C	Y	P	3.3	A3	9.0	Y			24603	70	29.98	49	3	85.0	3U	1900	1.0	F											
															2	85.0	3U	2000	1.0												
															4	85.0	3U	1800	1.0												
29-07	C	F	Y	P	3.3	A3	9.0	Y			10062	70	29.59	55	3	94.0	3U	2100	0.2	95.0	3L	1450	5.0								
															2	96.0	3U	2500	0.2												
															4	91.0	3L	1500	0.2												
29-22	C	F	Y	P	3.3	A3	9.0	Y			7735	70	29.55	55	3	91.0	2U	3800	0.8	91.0	3U	1500	6.0								
															2	92.0	2U	3800	0.8												
															4	89.0	3L	1400	1.0												
47-04	C	F	Y	P	3.3	A4	9.0	Y			21125	70	29.96	67	3	91.0	4L	1500	0.8	92.0	4L	1300	8.0								
															2	91.0	4L	1500	0.8												
															4	91.0	4L	1500	0.8												

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OBS. NO.	VEHICLE DESCRIPTION: TYP	ENG	F/A SYS	TRANS	SPARK ADVANCE: A/I	AS RCD	AS TST	ODOM MILES	WEATHER: AMB TMP	BAROM	HUM	FUEL	MAXIMUM: OCT NO	MAXIMUM: AGE R	MAXIMUM: RPM	MAXIMUM: VAC	PART-THROTTLE: OCT NO	PART-THROTTLE: AGE R	PART-THROTTLE: RPM	PART-THROTTLE: VAC	TANK FUEL INFORMATION: OWK	RATER: OCT	RATER: NO	RATER: KNI	RATER: GTE	RATER: AR	RATER: RPM	RATER: VAC
65-17	C	F	Y	P	3.3	A4	9.0	Y		11600	75	29.60	66	3	96.0	3U	1700	1.0	96.0	3U	1700	1.0								
														2					98.0	3U	1600	3.0								
														4	93.0	3U	1700	1.0												
07-09	C	F	Y	P	3.3	A4	9.0	Y		11344	84	30.07	50	3	82.0	4U	2300	0.0					N			N				
														2	85.0	4U	2300	0.0												
														4	82.0	4U	2500	0.0												
65-19	C	F	Y	P	3.3	A3	9.0	Y		6500	71	29.60	64	3	93.0	3U	2500	1.0	92.0	3U	2200	2.5	N	97.0	86.7	N				
														2	94.0	3U	2500	1.0												
														4	88.0	3L	2000	1.0												
06-09	C	F	N	P	3.8	A4	9.0	Y	-10	-10	6471	86	39.26	99	3	84.0	4U	2500	0.5	84.0	3U	2900	0.4	N	93.1	82.4	N				
														2	86.0	3U	2500	0.4												
														4	84.0	4U	2400	0.5												
28-07	C	F	N	P	3.8	A4	9.0	Y	+10	+10	10240	70	29.30	50	3	88.0	2U	2700	0.7	86.0	4L	1500	2.3								
														2	90.0	2U	2700	0.7												
														4	87.0	4L	1500	1.7												
26-01	C	F	N	P	3.8	A4	9.0	Y	+10	+10	9503	67	29.95	62	3	89.0	2U	3100	1.0	F											
														2	91.0	2U	3000	1.0												
														4	88.0	2U	3100	1.0												
26-06	C	F	N	P	3.8	A4	9.0	Y	+10	+10	8986	92	30.01	104	3	85.0	3U	3100	0.5	F											
														2	86.0	3U	3100	0.5												
														4	85.0	2U	2600	1.0												
29-04	C	F	N	P	3.8	A4	9.0	Y	+10	+10	10088	70	30.46	55	3	95.0	2U	2900	0.2	F											
														2	98.0	4L	1200	0.3												
														4	91.5	2U	2800	0.2												
29-20	C	F	N	P	3.8	A4	9.0	Y	+10	+10	10555	70	29.42	55	3	96.0	3U	1500	0.7	93.0	3U	1800	2.0								
														2	96.5	2U	3000	0.7												
														4	94.0	2U	2200	0.6												
47-23	C	C	N	P	3.8	A4	9.0	Y	+10	+10	9100	70	29.85	58	3	98.0	2U	3200	0.2	F											
														2	99.0	2U	3200	0.2												
														4	95.0	2U	3000	0.2												
07-12	C	F	N	P	3.8	A4	9.0	Y	+10	+10	16981	73	30.08	0	3	94.0	3U	2900	0.0												
														2	95.0	2U	4600	0.0												
														4	92.0	3U	2700	0.0												

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

	VEHICLE DESCRIPTION										WEATHER				OCTANE NUMBER REQUIREMENT DATA									TANK FUEL INFORMATION							
																MAXIMUM				PART-THROTTLE							RATER				
OBS. NO.	TYPE	EMCT	KS	F/A SYS	DSP	TRANS	C.R.	AIR	SPARK ADVANCE AS RCD	SPARK ADVANCE AS TST	ODOM MILES	AMB TMP	BAROM	HUM	FUEL	OCT NO	GEAR	RPM	VAC	OCT NO	GEAR	RPM	VAC	OWKNK	OCT NO RES	OCT NO MOTR	KNINT	THR	GEAR	RPM	VAC
23-17	C	F	Y	SP	3.8	A4	8.2	Y			13132	70	29.37	50	3	89.0	2U	2500	-8.5	28.0	2U	1600	-6.5								
															2	89.0	2U	2400	-8.5												
															4	89.0	2U	2400	-8.5												
40-06	C	F	Y	SP	3.8	A4	8.2	Y			14695	72	29.83	76	3	94.0	2U	2700	-9.0	94.0	3U	2600	-8.0								
															2	95.0	2U	2700	-9.0												
															4	96.0	2U	2500	-6.5												
47-26	C	C	Y	SP	3.8	A4	8.2	Y			11650	70	30.16	50	3	96.0	4U	1500	-6.0	96.0	4U	1500	0.0								
															2	97.0	4U	1500	-6.0												
															4	96.0	4U	1500	-6.0												
05-19	C	F	N	P	3.8	A4	9.0	Y	+10	+10	6108	70	27.90	36	3	92.0	2U	3000	1.0					N	98.8	87.7	N				
															2	95.0	2U	3300	1.0												
															4	91.0	2U	3100	1.0												
46-05	C	E	N	P	3.8	A4	9.0	Y	+10	+10	6782	73	28.71	88	3	95.0	2U	2950	1.0	F				Y	91.3	83.3	B	N	3U	2400	1.0
															2	94.0	2U	2900	1.0												
															4	91.0	2U	3000	1.0												
32-01	C	F	N	P	3.8	A4	9.0	Y	+10	+10	23721	70	28.94	50	3	88.0	4U	2650	1.3	88.0	4L	1650	3.0	N	91.5	83.0	N				
															2	90.0	2U	3400	1.0	90.0	3U	2600	2.0								
															4	88.0	4U	2700	1.3	88.0	4U	2650	3.0								
32-03	C	F	N	P	3.8	A4	9.0	Y	+10	+10	7737	70	29.46	50	3	86.0	4L	1700	1.0	86.0	4L	1650	2.0								
															2	87.0	4L	1600	1.0	87.0	4L	1700	2.0								
															4	86.0	4L	1800	1.0	86.0	4L	1700	2.0								
29-23	C	F	N	P	3.8	A4	9.0	Y	+10	+10	6109	70	29.52	55	3	88.5	2U	2300	1.0	87.0	4L	1450	2.2								
															2	89.5	3U	2300	1.0												
															4	87.0	2U	2300	1.0												
24-02	C	F	Y	P	3.8	A4	8.5	Y	---		18144	48	29.75	68	3	96.0	4L	1900	1.2	F											
															2	96.0	4L	1800	1.2												
															4	90.0	4L	1300	1.2												
26-15	C	F	Y	P	3.8	A4	8.5	Y			13254	87	29.97	130	3	L				L											
															2	L				L											
															4	L				L											
29-12	C	F	Y	P	3.8	A4	8.5	Y			13158	70	29.56	55	3	85.0	3U	1850	1.0												
															2	86.0	3U	1800	1.0												
															4	81.0	3L	1600	1.0												

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

OBS. NO.	VEHICLE DESCRIPTION: YEAR	MAKE	FUEL SYS	DISP	TRANS	SPARK ADVANCE: AIR	SPARK ADVANCE: AS RCD	SPARK ADVANCE: AS TST	C.R.	ODOM MILES	WEATHER: AMB TMP	BAROM	HUM	OCTANE NUMBER REQUIREMENT DATA: FUEL	MAXIMUM: OCT NO	MAXIMUM: GEAR	MAXIMUM: RPM	MAXIMUM: VAC	PART-THROTTLE: OCT NO	PART-THROTTLE: GEAR	PART-THROTTLE: RPM	PART-THROTTLE: VAC	TANK FUEL INFORMATION: WORK	RATER: OCT NO RES	RATER: OCT NO MOTR	RATER: KNIGHT	RATER: TEST	RATER: GAS	RATER: RPM	RATER: VAC
29-28	C	F	Y	P	3.8	A4			8.5	Y	14699	70	29.59	50	3	86.0	4L	1550	1.0	F										
															2	89.0	3U	1600	1.0											
															4	82.0	3U	2000	1.0											
47-08	C	C	Y	P	3.8	A4			8.5	Y	15600	70	30.00	58	3	85.0	4L	1500	0.5	85.0	4L	1500	4.5							
															2	85.0	4L	1500	0.5											
															4	82.0	4L	1500	0.5											
47-21	C	C	Y	P	3.8	A4			8.5	Y	7750	70	29.89	58	3	87.0	3U	3000	0.4	L										
															2	88.0	3U	3000	0.4											
															4	82.0	3U	2800	0.4											
08-10	C	F	Y	P	3.8	A4			8.5	Y	13769	79	29.84	89	3	80.0	4L	1375	1.0	L										
															2	80.0	4L	1425	1.0	80.0	3U	1825	2.5							
															4	76.0	3U	1925	1.0											
05-21	C	F	Y	P	3.8	A4			8.5	Y	7967	70	30.10	44	3	86.0	2U	2000	0.7					N	92.5	81.8	N			
															2	87.0	2U	2100	0.7											
															4	85.0	2U	2050	0.7											
06-18	C	F	Y	P	3.8	A4			8.5	Y	-20	-20	6377	87	30.06	106	3	L						N	92.8	82.9	N			
															2	80.0	3U	1300	0.4											
															4	78.0	3U	1200	0.4											
08-17	C	F	Y	P	3.8	A4			8.5	Y	23741	74	29.72	74	3	L				L										
															2	L														
															4	L														
28-10	C	F	Y	P	3.8	A4			8.5	Y	10094	70	29.38	50	3	87.0	2U	2100	0.7	87.0	3L	1500	6.0							
															2	89.0	2U	2000	0.7	89.0	3L	1450	7.0							
															4	84.0	2U	2000	0.7											
41-16	C	C	Y	P	3.8	A4			8.5	Y	--		13885	61	30.09	44	3	80.0	2U	3200	0.9	L								
															2	82.0	2U	2400	0.9											
															4	80.0	2U	2700	0.9											
46-10	C	E	Y	P	3.8	A4			8.5	Y	12000	72	29.36	82	3	L				L				N	91.5	82.8	N			
															2	80.0	3U	2150	0.7											
															4	78.0	3U	2025	0.7											
65-08	C	F	Y	P	3.8	A4			8.5	Y	26100	78	29.30	62	3					90.5	3U	2300	3.0							
															2					91.5	3U	2300	3.0							
															4	81.0	4L	1700	0.0											

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	VEHICLE DESCRIPTION											WEATHER			OCTANE NUMBER REQUIREMENT DATA									TANK FUEL INFORMATION							
																MAXIMUM				PART-THROTTLE							RATER				
OBS. NO.	TYPE	ENCT	KS	F/A SYS	DSP	TRANS	C.R.	AIR	SPARK ADVANCE AS RCD	AS TST	ODOM MILES	AMB TMP	BAROM	HUM	FUEL	OCT NO	GEAR	RPM	VAC	OCT NO	GEAR	RPM	VAC	OWKNK	OCT NO RES	OCT NO MOTR	KNINT	THR	GEAR	RPM	VAC
65-27	C	F	Y	P	3.8	A4	8.5	Y			6300	75	29.50	45	3	89.0	3U	2200	0.5	89.5	3U	1750	5.0	N	93.0	81.8	N				
															2	90.0	3U	2000	0.5												
															4	88.0	3U	2000	0.5												
46-11	C	E	Y	P	4.0	A4	10.0	Y			8224	72	29.37	82	3	89.0	3U	2450	1.0	87.0	4U	2075	2.5	N	93.4	85.5	N				
															2	91.0	3U	1800	1.0												
															4	88.0	3U	1900	1.0												
06-25	C	F	N	P	4.5	A4	9.5	Y	+12	+10	6166	86	30.05	102	3	94.0	4U	2200	2.8	92.0	4U	2200	2.0	N							
															2	95.0	4U	3400	2.8												
															4	93.0	4U	2500	2.8												
08-01	C	F	N	P	4.5	A4	9.5	Y	+10	+10	19432	76	29.98	43	3	91.0	4L	2000	1.0	90.0	3U	2550	5.0								
															2	93.0	2U	3300	0.9	92.0	3U	2650	5.0								
															4	88.0	3U	2600	1.0												
28-12	C	F	N	P	4.5	A4	9.5	Y	+10	+10	10018	70	29.42	50	3	92.0	4L	1500	1.3	91.0	4L	1400	2.5								
															2	92.0	4L	1500	1.3												
															4	92.0	4L	1500	1.3												
28-23	C	F	N	P	4.5	A4	9.5	Y			9243	70	29.34	50	3	92.0	2U	2700	0.5	91.0	4L	1300	1.7								
															2	93.0	2U	2700	0.5												
															4	92.0	2U	2700	0.5												
46-09	C	E	N	P	4.5	A4	9.5	Y	+10	+10	15742	70	29.26	82	3	92.0	4L	1675	1.0	92.0	4L	1775	2.0	N	95.3	87.4	N				
															2	93.0	4L	1700	1.0												
															4	91.0	4L	1650	1.0	92.0	4L	1650	2.0								
47-12	C	C	N	P	4.5	A4	9.5	Y	+10	+10	7800	70	29.97	68	3	99.0	4L	1600	0.2	98.0	4L	1200	10.0								
															2	99.0	4L	1750	0.2												
															4	99.0	4L	1500	0.2												
65-15	C	F	N	P	4.5	A4	9.5	Y	+10	+10	6560	66	29.80	39	3	93.5	4L	1500	1.0	92.5	4L	1500	2.0								
															2	95.0	2U	2700	1.0												
															4	92.5	4L	1500	1.0												
47-15	C	C	N	P	5.0	M5	9.0	Y	+10	+10	8600	70	29.89	50	3	93.0	4	3000	0.0	94.0	4	1100	6.0	N	98.6	87.3	N				
															2	94.0	4	3000	0.0												
															4	92.0	4	900	0.0												
28-18	C	F	N	P	5.0	A4	9.0	Y	+10	+10	10473	70	29.32	50	3	91.0	4L	1400	1.0	90.0	4L	1300	2.3								
															2	92.0	2U	3200	0.7												
															4	91.0	4L	1500	1.0												

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

	VEHICLE DESCRIPTION										WEATHER			OCTANE NUMBER REQUIREMENT DATA								TANK FUEL INFORMATION							
															MAXIMUM				PART-THROTTLE						RATER			
				T		SPARK							F		G				G				O		K			
	T	E	F/A	R		ADVANCE							U		E				E				W		N	G		
	Y	M	S	A		A							E	OCT	A			OCT	A			K	OCT	MO	I	T	E	
CBS.	P	C	K	Y		I	AS	AS	ODOM	AMB			L	NO	R	RPM	VAC	NO	R	RPM	VAC	N	RES	MOTR	N	H	A	
NO.	E	T	S	S	DSP	S	C.R.	R	RCD	TST	MILES	TMP	BAROM	NUM	-								K			T	R	R	RPM	VAC
06-12	C	F	N	P	5.0	A4	8.9	Y	-10	-10	13008	81	30.09	110	3	90.0	4U	1400	0.6	88.5	4U	1400	2.0	N						
															2	90.0	4U	1500	0.6										
															4	89.0	4U	1250	0.6										
41-30	C	C	N	P	5.0	A4	8.9	Y	+10	+10	7373	78	30.23	52	3	93.5	4L	1025	0.9	93.0	3U	1350	3.0							
															2	94.0	4L	1000	0.9										
															4	92.0	4L	1100	0.9										
40-15	C	F	N	P	5.0	A4	8.9	Y	+10	+10	8310	52	29.00	70	3	92.0	4	1350	0.0	89.0	4	1450	1.0							
															2	93.0	3	2200	0.0										
															4	92.0	4	1700	0.0										
29-09	C	F	N	P	5.0	A4	8.9	Y	+10	+10	12501	70		55	3	88.0	2U	2300	1.0	86.0	4L	1300	6.0							
															2	88.5	2U	2300	1.0										
															4	89.0	4L	1200	1.0										
05-30	C	F	N	P	5.0	A4	8.9	Y	+10	+10	9228	70	29.92	50	3	93.0	2U	2180	1.0	F				N	97.7	88.0	N			
															2	94.0	3U	2120	1.0										
															4	91.0	2U	1880	1.0										
26-17	C	F	N	P	5.0	A4	8.9	Y	+10	+10	6016	93	29.90	121	3	88.0	4L	1600	0.5	87.0	4L	1050	1.5							
															2	89.0	4L	1550	0.5										
															4	87.0	4L	1600	0.5										
28-19	C	F	N	P	5.0	A4	8.9	Y	+10	+10	10628	70	29.20	50	3	91.0	4L	1000	1.3	89.0	4L	1200	2.3							
															2	91.0	4L	3000	1.0										
															4	91.0	4L	1000	1.3										
41-07	C	C	N	P	5.0	A4	8.9	Y	+10	+10	7258	72	30.00	56	3	89.0	2U	3200	1.0											
															2	91.0	2U	3300	1.0										
															4	87.0	2U	3400	1.0										
65-04	C	F	N	P	5.0	A4	8.9	Y	+10	+10	7050	70	29.60	84	3	90.0	4U	1100	0.5	90.5	3U	1200	3.0							
															2	90.5	4U	1100	0.5										
															4	91.5	4U	1200	0.5										
32-05	C	F	N	P	5.0	A4	9.0	Y	+10	+10	20336	70	29.63	50	3	88.0	4	1300	0.6	88.0	4	1400	2.0	N	92.4	82.9	B	M	3U	3000	0.6
															2	88.0	4	1500	0.6	88.0	4	1500	2.0							
															4	88.0	4	1200	0.6	88.0	4	1400	2.0							
26-23	C	F	Y	T	5.0	A4	9.3	Y	+ 0	+ 0	9786	78	29.93	112	3	90.0	4U	1850	1.0	90.0	3U	1950	2.0	N				N		
															2	92.0	3U	1650	1.0										
															4	89.0	4U	1900	1.0										

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OBS. NO.	TYPE	EMCT	KS	F/A SYS	DSP	TRANS	C.R.	AIR	SPARK ADVANCE AS RCD	SPARK ADVANCE AS TST	ODOM MILES	AMB TMP	BAROM	HUM	FUEL	MAXIMUM OCT NO	MAXIMUM GEAR	MAXIMUM RPM	MAXIMUM VAC	PART-THROTTLE OCT NO	PART-THROTTLE GEAR	PART-THROTTLE RPM	PART-THROTTLE VAC	OWKNK	OCT NO RES	OCT NO MOTR	RATER KNINT	RATER THR	RATER GEAR	RATER RPM	RATER VAC
41-27	C	C	Y	P	5.7	M6	9.5	Y	+ 6	+ 6	9049	80	29.90	32	3	91.0	5	2000	0.0	91.0	4	2450	3.0	N			A	M	5	2000	0.0
															2	94.0	5	1800	0.0												
															4	89.0	5	2050	0.0												
05-18	C	F	Y	T	5.7	A4	9.3	Y	+ 0	+ 0	6544	70	29.60	62	3	94.0	2U	3100	1.0					N	96.7	89.5	N				
															2	95.0	2U	2950	1.0												
															4	93.0	2U	3000	1.0												
47-27	T	C	N	P	2.2	A3	8.6	Y	+ 6	+ 6	8365	70	30.08	50	3	89.0	4L	2500	0.3												
															2	89.0	4L	2700	0.3												
															4	88.0	4L	2500	0.3												
26-22	T	F	N	P	2.3	M5	9.2	Y	+10	+10	7710	94	30.02	120	3	93.0	4	1425	0.1	93.0	4	1450	1.0	N			B	M	4	1520	0.1
															2	94.0	4	1550	0.1												
															4	94.0	4	1600	0.1												
26-20	T	F	N	2	2.3	M5	8.3	Y	+ 6	+ 6	7865	92	29.94	129	3	86.0	5	2825	0.5					N			N				
															2	89.0	5	2825	0.5												
															4	86.0	5	1375	0.5												
28-16	T	F	Y	P	2.4	A4	9.3	Y	+ 5	+ 5	10667	70	29.45	50	3	91.0	3L	2400	0.7	90.0	3L	2400	2.5								
															2	92.0	3L	2500	0.7												
															4	90.0	3L	2400	0.7												
29-15	T	F	N	T	2.5	A3	8.9	Y	+12	+12	18439	70	29.65	55	3	87.0	2U	2500	0.6	86.5	3U	2000	2.5								
															2	88.0	3U	2600	1.0												
															4	86.0	3U	2700	1.0												
06-11	T	F	N	T	2.5	A3	8.9	Y	-12	-12	18687	82	29.99	139	3	87.0	3U	2500	0.4	85.0	3L	2600	2.0	N	97.2	86.4					
															2	86.5	3U	2700	0.4	86.0	3U	2300	3.0								
															4	85.0	3U	2600	0.4												
25-05	T	E	N	T	2.5	M5	9.2	Y	‾--		10996	80	29.54	100	3	90.0	4	3100	1.0	90.0	4	2400	3.0	N	98.5	88.1	N				
															2	92.0	4	3200	1.0												
															4	88.0	4	2800	1.0												
05-05	T	F	N	T	2.5	M5	8.3	N			15000	70	30.15	50	3	93.0	4	1380	0.2	F				N	92.3	82.5	A	P	4	3250	4.0
															2	94.0	4	1700	0.1												
															4	92.0	4	1480	0.4												
47-16	T	C	N	P	2.6	M5	8.4	Y	+ 4	+ 4	11400	70	29.89	50	3	89.0	4	1250	0.0	85.0	4	1250	1.0								
															2	89.0	4	1250	0.0												
															4	89.0	4	1250	0.0												

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

	VEHICLE DESCRIPTION										WEATHER			OCTANE NUMBER REQUIREMENT DATA								TANK FUEL INFORMATION						
								SPARK ADVANCE							MAXIMUM				PART-THROTTLE						RATER			
OBS. NO.	TYPE	TEST	F/A	TRANS	AIR	C.R.	R	AS RCD	AS TST	ODOM MILES	AMB TMP	BAROM	HUM	FUEL	OCT NO	GEAR	RPM	VAC	OCT NO	GEAR	RPM	VAC	OWK	OCT NO RES	OCT NO MOTR	KNIT	GHAR	GEAR	RPM	VAC
06-26	T	F	N	P	3.0	A3	8.9	Y	+12	+12	13370	75	30.14	102	3	86.0	3U	2600	1.6	85.0	3L	1700	2.2	N			N				
															2	86.5	3U	2550	1.6	86.0	3L	1700	2.5								
															4	85.0	3L	1700	1.2												
05-25	T	F	N	P	3.0	A4	8.9	Y	+12	+12	6414	70	30.10	35	3	90.0	3U	2500	1.0					N	90.9	83.4	B	M	3L	2600	1.0
															2	92.0	3U	2500	1.0												
															4	89.0	3U	2600	1.0												
40-04	T	F	N	P	3.0	A4	8.9	Y	+12	+12	13709	84	29.62	64	3	88.0	4L	1900	1.0	86.0	4L	1900	2.5								
															2	89.0	3U	2500	0.0												
															4	87.0	2U	2500	0.0												
07-03	T	F	N	P	3.0	A4	8.9	Y	+12	+12	20930	73	30.45	24	3	87.0	3U	2800	0.0												
															2	87.0	3U	2800	0.0												
															4	84.0	3U	2800	0.0												
07-04	T	F	N	P	3.0	A4	8.9	Y	+12	+12	20368	69	30.30	0	3	86.0	3U	3700	0.0												
															2	87.0	4U	3500	0.0												
															4	84.0	3U	3400	0.0												
05-15	T	F	N	P	3.0	A4	8.9	Y	+12	+12	6967	68	29.80	48	3	89.0	3U	2400	1.0					N	95.2	83.6	N				
															2	90.0	3U	2500	1.0												
															4	87.0	3U	2300	1.0												
65-05	T	F	N	P	3.0	A4	8.9	Y	+12	+12	13750	75	29.60	92	3	86.5	2U	2900	0.0	86.0	4U	2600	4.0								
															2	87.0	2U	2900	0.0												
															4	85.5	2U	2900	0.0												
26-16	T	F	N	P	3.0	A4	9.3	Y	+10	+10	9487	91	29.96	118	3	91.0	4L	1750	0.5	91.0	4L	1900	2.0	N			N				
															2	91.0	4L	1800	0.5												
															4	90.0	4L	1850	0.5												
41-04	T	C	N	P	3.0	A4	9.3	Y	+10	+10	7019	76	29.92	54	3	86.0	4L	1950	0.7	F											
															2	86.0	4L	1950	0.7												
															4	85.0	4L	2200	0.7												
47-28	T	C	N	P	3.0	A4	9.3	Y	+10	+10	9133	70	30.09	50	3	90.0	4L	2000	0.5	90.0	4L	2000	1.5								
															2	91.0	4L	2000	0.5												
															4	89.0	4L	2000	0.5												
07-15	T	F	N	P	3.0	A4	9.3	Y			16020	70	30.32	55	3	93.0	2U	4000	0.0					N			N				
															2	95.0	2U	4200	0.0												
															4	92.0	4L	2100	0.0												

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

	VEHICLE DESCRIPTION											WEATHER			OCTANE NUMBER REQUIREMENT DATA									TANK FUEL INFORMATION							
															MAXIMUM				PART-THROTTLE								RATER				
OBS. NO.	TYPE	EMCT	KS	F/A SYS	DSP	TRANS	C.R.	AIR	SPARK ADVANCE AS RCD	SPARK ADVANCE AS TST	ODOM MILES	AMB TMP	BAROM	HUM	FUEL	OCT NO	GEAR	RPM	VAC	OCT NO	GEAR	RPM	VAC	OWKNK	OCT NO RES	OCT NO MOTR	KNINT	THR	GEAR	RPM	VAC
06-13	T	F	N	P	3.0	A4	8.5	Y	-11	-11	9964	79	30.21	113	3	84.0	4U	1750	0.6	82.0	3L	1850	2.0	N	98.9	88.2	N				
															2	85.0	4U	1750	0.6												
															4	84.0	4U	1800	0.6												
62-06	T	F	N	T	3.0	A4	9.0	Y	+15	+15	6242	60	29.52	41	3	84.0	4L	1750	1.8	84.0	4L	1700	3.8								
															2	85.0	3U	3000	0.2	85.0	3U	2250	2.2								
															4																
60-04	T	F	Y	P	3.0	A4	9.0	Y	+10	+10	8000	71	29.42	43	3	85.0	3U	2400	1.6	84.0	3U	2400	2.8								
															2	86.0	3U	2400	1.6	85.0	3U	2400	2.8								
															4																
08-23	T	F	Y	T	3.1	A3	9.1	Y	+10	+10	7050	76	30.09	27	3	86.0	2U	3000	1.2	85.0	3U	2750	4.0								
															2	87.0	2U	3000	1.2												
															4	84.0	2U	2950	1.2												
08-24	T	F	Y	T	3.1	A3	9.1	Y	+10	+10	7386	80	30.02	33	3	82.0	2U	2900	1.2	L											
															2	84.0	2U	2900	1.2												
															4	80.0	2U	3000	1.2												
07-11	T	F	Y	T	3.1	A3	9.1	Y	+10	+10	14350	70	30.37	70	3	94.0	2U	3100	0.0					N							
															2	95.0	2U	3100	0.0												
															4	90.0	2U	2900	0.0												
28-02	T	F	Y	T	3.1	A3	9.1	Y	+10	+10	10146	70	29.07	50	3	85.0	2U	2600	0.7	82.0	2U	2500	2.0								
															2	85.0	2U	2300	0.7												
															4	83.0	2U	2700	0.7												
46-15	T	E	Y	T	3.1	A3	9.1	Y	+10	+10	13340	72	29.43	45	3	86.0	3L	2100	1.5	85.0	3L	1800	3.0	N	94.5	87.5	N				
															2	91.0	3U	2400	1.5												
															4	85.0	3L	2300	1.5												
29-10	T	F	Y	T	3.1	A3	9.1	Y	+10	+10	20036	70	29.56	55	3	95.0	3U	2500	3.0	94.0	3L	2000	6.0								
															2	98.0	3U	2500	3.0												
															4	87.0	3L	1800	2.0												
47-09	T	C	Y	T	3.1	A3	9.1	Y	+10	+10	6900	70	30.04	50	3	95.0	3L	2000	1.5	92.0	3L	2000	2.5	N	92.4	83.0	B	M	3L	2000	1.5
															2	95.0	3L	2500	1.5												
															4	93.0	3L	1900	1.5												
05-22	T	F	Y	P	3.3	A4	8.9	Y			6545	70	30.08	50	3	87.0	3U	2450	1.0	F				N	92.0	82.2	B	M	3	2330	1.2
															2	92.0	3U	2460	1.2												
															4	85.0	3U	2360	1.0												

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	VEHICLE DESCRIPTION									WEATHER				OCTANE NUMBER REQUIREMENT DATA								TANK FUEL INFORMATION						
															MAXIMUM				PART-THROTTLE								
					T		SPARK							F		G			G			O		K		
	T	E	F/A		R		ADVANCE							U		E			E			W		N	G	
	Y	M	S		A		A	-------						E	OCT	A		OCT	A			K	OCT	NO	I	T	E
OBS.	P	C	K	Y		N		I	AS	AS	ODOM	AMB			L	NO	R	RPM	VAC	NO	R	RPM	VAC	N	----------		N	H	A
NO.	E	T	S	S	DSP	S	C.R.	R	RCD	TST	MILES	TMP	BAROM	HUM										K	RES	MOTR	T	R	R	RPM	VAC
05-28	T	F	Y	P	3.3	A4	8.9	Y			15500	71	29.90	50	3	88.0	3U	2440	1.2	F										
															2	89.0	4L	1800	1.4											
															4	86.0	4L	2200	1.4											
06-15	T	F	Y	P	3.3	A4	8.9	Y			8230	82	29.80	120	3	L				L				N	94.5	84.7	N				
															2	L															
															4	L															
41-06	T	C	Y	P	3.3	A4	8.9	Y			9020	71	29.95	49	3	87.0	4U	2250	1.5	F										
															2	88.0	4U	2200	1.5											
															4	86.0	4U	2300	1.5											
46-02	T	E	Y	P	3.3	A4	8.9	Y			6884	70	29.35	88	3	L				L				N	92.0	81.9	N				
															2	L															
															4	L															
07-08	T	F	Y	P	3.3	A4	8.9	Y			26329	70	29.69	0	3	84.0	3U	2500	0.0					N			N				
															2	85.0	3U	2500	0.0											
															4	81.0	2U	3400	0.0											
05-26	T	F	Y	P	3.3	A4	8.9	Y			28799	72	29.90	48	3	88.0	2U	2300	0.5											
															2	89.0	2U	2400	0.5											
															4	87.0	2U	2500	0.5											
08-28	T	A	Y	P	3.3	A4	8.9	Y			17242	74	29.86	34	3	L				L										
															2	L															
															4	76.0	3U	2200	1.1											
24-04	T	F	Y	P	3.3	A4	8.9	Y			14176	45	29.72	66	3	88.0	3U	2200	0.7	85.0	3U	2400	4.0							
															2	89.0	3U	2300	0.7											
															4	86.0	3U	2300	0.7											
28-03	T	F	Y	P	3.3	A4	8.9	Y			10089	70	29.22	50	3	80.0	2U	1700	1.0	L										
															2	81.0	2U	1800	1.0											
															4	79.0	2U	1700	1.0											
46-18	T	E	Y	P	3.3	A4	8.9	Y			8673	73	29.47	30	3	L				L				N	92.7	82.0	N				
															2	L															
															4	L															
29-08	T	F	Y	P	3.3	A4	8.9	Y			12545	70		55	3	89.0	3U	2000	1.0	85.0	4L	1600	3.5							
															2	93.0	3U	1900	1.0											
															4	86.0	3U	1800	1.0											

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	VEHICLE DESCRIPTION									WEATHER				OCTANE NUMBER REQUIREMENT DATA								TANK FUEL INFORMATION							
							SPARK ADVANCE							MAXIMUM				PART-THROTTLE											
OBS. NO.	TYPE	EM CT	F/A KS	SYS	TRANS DSP	TRANS	C.R.	AIR RCD	AS TST	ODOM MILES	AMB TMP	BAROM	HUM	FUEL LEVEL	OCT NO	GEAR	RPM	VAC	OCT NO	GEAR	RPM	VAC	OWNK	OCT NO RES	OCT NO MOTR	KNIT GHAR	GRADE	RPM	VAC
29-27	T	F	Y	P	3.3	A4	8.9	Y		17540	70	29.58	55	3	82.0	4L	1600	1.0					F						
														2	86.0	3U	2450	1.0											
														4	81.0	4L	1600	1.0											
47-06	T	C	Y	P	3.3	A4	8.9	Y		12600	70	29.97	64	3	86.0	3L	1900	0.8	85.0	3L	1900	2.0							
														2	87.0	3L	1900	0.8											
														4	85.0	3L	1800	0.8											
65-22	T	F	Y	P	3.3	A4	8.9	Y		7200	77	29.80	46	3	80.0	2U	2400	0.5					L						
														2	80.0	2U	2400	0.5											
														4	80.0	2U	2400	0.5											
25-07	T	E	N	T	3.9	A3	9.2	Y	+10 +10	11739	86	29.47	87	3	92.0	3U	1800	1.3	93.0	3U	1700	5.0	N	91.9	82.5	A M	3L	2000	1.5
														2	93.0	2U	1900	1.3											
														4	92.0	2U	1800	1.3											
40-08	T	F	N	T	3.9	A4	9.2	N	+10 +10	8674	76	30.08	72	3	89.0	4U	1800	2.0	87.0	4U	1600	3.0							
														2	89.0	4U	1800	2.0											
														4	89.0	4U	1800	2.0											
25-04	T	E	Y	P	4.0	A4	8.8	Y		29737	87	29.47	78	3	90.0	3L	2300	1.0	89.0	4L	1600	3.5	N	92.2	83.3	A M	3L	2400	1.0
														2	91.0	3L	2300	1.0											
														4	88.0	3L	2700	1.0											
26-26	T	F	Y	P	4.0	A4	8.8	Y		13691	87	29.94	146	3	89.0	3L	1400	0.5	89.0			0.0	N			N			
														2	92.0	2U	4200	0.5	93.0			0.0							
														4	88.0	2U	2600	0.5											
41-12	T	C	Y	P	4.0	A4	8.8	Y		15835	70	30.12	27	3	95.0	4L	1400	1.4	F										
														2	97.0	4L	1300	1.4	98.0	4L	1300	4.0							
														4	94.0	4U	2000	0.8											
06-22	T	F	N	P	4.0	A4	9.0	Y		9631	78	29.70	92	3	86.0	4L	2300	0.4	84.0	4L	2400	2.0	N	94.5	84.3	N			
														2	86.5	4U	3000	0.4											
														4	85.5	4U	2800	0.4											
28-13	T	F	N	P	4.0	A4	9.0	Y		9665	70	29.29	50	3	84.0	4L	2200	1.0	83.0	4L	2300	2.0							
														2	85.0	4L	2100	1.0											
														4	83.0	4L	2200	1.0											
26-19	T	F	N	P	4.0	A4	9.0	Y	+10 +10	10740	94	29.93	113	3	88.0	4L	1650	0.5	88.0	4L	1650	1.5							
														2	90.0	4L	1650	0.5											
														4	87.0	4L	1625	0.5											

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	VEHICLE DESCRIPTION										WEATHER			OCTANE NUMBER REQUIREMENT DATA								TANK FUEL INFORMATION							
															MAXIMUM				PART-THROTTLE									
					T		SPARK							F		G			G			O		K			
	T	E	F/A		R		ADVANCE							U		E			E			W		N	G		
	Y	M	S		A		A							E	OCT	A			OCT	A		K	OCT	NO	I	T	E	
OBS.	P	C	K	Y	N		I	AS	AS	ODOM	AMB			L	NO	R	RPM	VAC	NO	R	RPM	VAC	N	RES	MOTR	N	H	A	
NO.	E	T	S	S	DSP	S	C.R.	R	RCD	TST	MILES	TMP	BAROM	HUM									K			T	R	R	RPM	VAC
32-02	T	F	N	P	4.0	A4	9.0	Y	+10	+10	13186	70	29.40	50	3	86.0	4L	2400	1.2	86.0	4L	2300	3.0							
															2	86.0	4L	2300	1.2	86.0	4L	2300	3.0							
															4	86.0	4L	2400	1.2	86.0	4L	2400	3.0							
25-06	T	E	N	2	4.2	M5	8.6	Y	+ 9	+ 9	19199	74	29.59	112	3	87.0	4	1200	1.0	87.0	4	1200	2.0	N	92.2	83.5	N				
															2	89.0	4	1200	1.0											
															4	84.0	4	1400	1.0											
05-24	T	F	Y	T	4.3	A4	9.3	Y	+ 0	+ 0	6054	70	29.90	52	3	89.0	2U	3800	0.5					N	91.7	81.9	B	M	2U	3750	0.5
															2	91.0	2U	3800	0.5											
															4	89.0	2U	3650	0.5											
06-20	T	F	Y	T	4.3	A4	9.3	Y	+ 0	+ 0	14450	71	30.11	93	3	85.0	3U	2700	0.4	82.0	3U	2400	1.4	N	95.2		B	M	3U	2400	0.4
															2	85.0	4U	2200	0.6											
															4	82.0	4U	2200	0.6											
26-21	T	F	Y	T	4.3	A4	9.3	Y	+ 0	+ 0	19600	93	30.12	128	3	85.0	4U	2300	0.5	83.0	4L	1200	2.0	N			N				
															2	85.0	4L	1325	1.0											
															4	84.0	4U	1950	0.5											
47-17	T	C	Y	T	4.3	A4	9.3	Y	+ 0	+ 0	10400	70	30.06	54	3	100.0	2U	4250	0.2	F				N	92.5	83.0	A	M	2U	4000	0.2
															2	101.0	2U	4250	0.2											
															4	89.0	3U	2250	0.2											
41-13	T	C	Y	T	4.3	A4	9.3	Y	+ 0	+ 0	11669	78	30.09	43	3	89.0	4L	1300	0.9	F											
															2	89.0	3U	2050	0.8											
															4	89.0	3U	2100	0.8											
46-20	T	E	Y	T	4.3	A4	9.3	Y	+ 0	+ 0	7290	76	29.10	35	3	94.0	4L	1410	1.0	90.0	4L	1375	2.0	N	92.8	81.3					
															2	95.0	3U	2410	1.0											
															4	92.0	4L	1475	1.0											
29-26	T	F	Y	T	4.3	A4	9.3	Y	+ 0	+ 0	14806	70	29.50	55	3	99.0	3U	2000	0.8	F											
															2	99.0	2U	2400	0.8											
															4	H			0.0												
65-11	T	F	Y	T	4.3	A4	9.3	Y	+ 0	+ 0	9750	75	29.80	106	3	91.0	3U	2300	0.0	89.0	4L	1450	1.5								
															2	91.5	3U	2400	0.0											
															4	90.5	3U	2200	0.0											
46-13	T	E	Y	T	4.3	M5	9.3	Y	+ 0	+ 0	8976	70	29.27	65	3	92.0	3	2500	0.3	91.0	4	1550	2.0	N	91.3	83.0					
															2	91.0	4	2100	0.3											
															4	91.0	3	2175	0.3											

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	VEHICLE DESCRIPTION											WEATHER			OCTANE NUMBER REQUIREMENT DATA: MAXIMUM					PART-THROTTLE				TANK FUEL INFORMATION			RATER				
OBS. NO.	TYPE	EMCT	KS	F/A SYS	DSP	TRANS	C.R.	AIR	SPARK ADVANCE AS RCD	AS TST	ODOM MILES	AMB TMP	BAROM	HUM	FUEL	OCT NO	GEAR	RPM	VAC	OCT NO	GEAR	RPM	VAC	OWKNK	OCT NO RES	MOTR	KNINT	THR	GEAR	RPM	VAC
65-24	T	F	Y	T	4.3	A4	9.3	Y	+ 0	+ 0	9700	75	29.60	54	3	91.0	2U	2500	0.5	90.0	4L	1700	1.5								
															2	92.0	2U	3200	0.5												
															4	89.0	2U	2500	0.5												
07-19	T	F	Y	P	4.9	A4	8.8	Y	+10	+10	6473	62	30.12	25	3	90.0	2U	2400	0.0					N			N				
															2	89.0	2U	2400	0.0												
															4	89.0	3U	2350	0.0												
05-20	T	F	Y	P	4.9	A3	8.8	N	+10	+10	20090	70	29.90	48	3	88.0	2	2000	1.5						82.1	82.3					
															2	89.0	2	1950	1.5												
															4	87.0	2	2050	1.5												
29-17	T	F	Y	P	4.9	A3	8.8	Y	+10	+10	10511	70	29.50	55	3	92.0	2	1800	1.0	89.0	3	1800	2.5								
															2	92.0	2	2200	1.0												
															4	90.5	2	2300	1.0												
28-20	T	F	Y	P	5.0	A4	9.0	Y	+10	+10	13620	70	29.46	50	3	86.0	3L	1350	1.5	85.0	3L	1300	2.5								
															2	87.0	3L	1300	1.5												
															4	86.0	3L	1300	1.5												
29-21	T	F	Y	P	5.0	A4	9.0	Y	+10	+10	8452	70	29.55	50	3	90.0	3U	1200	0.8	89.0	4U	1925	4.0								
															2	90.0	3U	1600	0.8												
															4	90.5	3U	2200	0.8												
32-06	T	F	Y	P	5.0	A4	9.0	Y	+10	+10	16781	70	29.29	50	3	88.0	4U	1700	2.0	88.0	4U	1600	4.0	N	91.4	83.0	N				
															2	88.0	4U	1900	2.0	89.0	4U	1900	4.0								
															4	88.0	4U	1700	2.0	88.0	4U	1500	4.0								
05-23	T	F	Y	T	5.0	A3	9.2	Y	+ 0	+ 0	11060	70	30.00	45	3	89.0	3	1850	1.5												
															2	91.0	3	1800	1.5												
															4	88.0	3	1900	1.5												
40-11	T	F	Y	T	5.0	A3	9.2	N	+-0.	+ 0	13646	61	29.70	47	3	90.0	3	2800	0.0	86.0	3	3000	2.0								
															2	90.0	3	2600	0.0												
															4	90.0	3	2800	0.0												
41-28	T	C	Y	T	5.0	A4	9.2	N	+ 0	+ 0	6417	78	30.11	49	3	87.0	3U	2100	1.2	F											
															2	89.0	3U	2100	1.2												
															4	86.0	3U	2200	1.2												
07-16	T	F	Y	T	5.0	A4	9.2	Y	+ 0	+ 0	13094	71	30.25	64	3	93.0	3U	2250	0.0					N			N				
															2	91.0	3U	2650	0.0												
															4	93.0	4U	2250	0.0												

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

OBS. NO.	VEHICLE DESCRIPTION: TYP	EMI	CKT	F/A SYS	DSP	TRANS	C.R.	SPARK ADVANCE: AIR	ASD	AST	ODOM MILES	WEATHER: AMB TMP	BAROM	HUM	OCTANE NUMBER REQUIREMENT DATA: FUEL	MAXIMUM: OCT NO	GEAR	RPM	VAC	PART-THROTTLE: OCT NO	GEAR	RPM	VAC	TANK FUEL INFORMATION: OWNK	RATER: OCT NO RES	OCT NO MOTR	KNIT	GEAR	RPM	VAC
25-02	T	E	N	T	5.2	A4	9.2	Y	+10	+10	15463	88	29.47	120	3	88.0	4U	1700	1.0											
															2	90.0	4U	1700	1.3											
															4	87.0	4U	1650	1.3											
65-26	T	F	Y	T	5.7	A4	9.1	Y	+ 0	+ 0	18800	74	29.50	47	3	92.0	3U	2700	1.0	89.0	4L	1500	2.0	N	92.0	83.2	A M	4L	1800	1.0
															2	94.0	3U	2600	1.0											
															4	90.0	2U	2400	1.0											
28-26	T	F	Y	T	5.7	A4	9.1	Y	+ 0	+ 0	12229	70	29.44	50	3	89.0	4U	1400	2.7	88.0	4L	1200	2.0							
															2	90.0	4U	1400	2.7											
															4	88.0	4L	1200	1.0											
41-19	T	C	Y	T	5.7	A4	9.1	N	+ 0	+ 0	7074	73	30.19	40	3	90.0	3U	2400	2.6	F										
															2	90.0	3U	2250	2.6											
															4	89.0	3U	2300	2.6											
46-07	T	E	Y	T	5.7	A4	9.1	Y	+ 0	+ 0	7767	78	29.35	87	3	90.0	3U	2100	1.0	90.0	4L	1460	1.5	N	91.5	82.9				
															2	91.0	3U	2150	1.0											
															4	90.0	3U	2100	1.0											
46-17	T	E	Y	T	5.7	M5	9.1	Y	+ 0	+ 0	10261	72	29.89	34	3	91.0	3	2725	0.0	90.0	4	1825	1.0	N	95.9	86.2				
															2	91.0	4	1275	0.0											
															4	89.0	3	1675	0.0											
26-25	T	F	Y	T	5.7	A4	9.1	Y	+ 0	+ 0	10289	91	30.02	119	3	91.0	4U	2250	1.5	91.0	4U	2350	2.5	N			N			
															2	91.0	3U	2500	1.0											
															4	90.0	4U	2300	1.5											
41-18	T	C	Y	T	5.7	A4	9.1	Y	+ 0	+ 0	12987	86	30.00	22	3	87.0	3U	2050	1.2	F										
															2	88.0	3U	2100	1.2											
															4	86.0	3U	2100	1.2											
40-12	T	F	Y	T	5.7	A4	9.1	N	+ 4	+ 4	6625	59	29.87	58	3	95.0	3U	2800	0.0	93.0	3U	2600	2.0							
															2	96.0	2U	3800	0.0											
															4	92.0	2U	3000	0.0											
46-14	T	E	Y	T	5.7	A4	9.1	Y	+ 0	+ 0	13594	70	29.69	32	3	95.0	3U	2100	1.0	91.0	4L	1450	2.5	N	92.0	82.8	B M	3U	2900	1.0
															2	96.0	3U	1875	1.0											
															4	92.0	3U	2150	1.0											
65-23	T	F	Y	T	5.7	A4	9.1	N	+ 4	+ 4	9700	74	29.60	68	3	91.0	3U	2900	0.8	88.0	3U	3000	2.0							
															2	92.0	3U	2850	0.8											
															4	87.0	3U	3000	0.8											

1990 CRC OCTANE NUMBER REQUIREMENT SURVEY

	VEHICLE DESCRIPTION											WEATHER			OCTANE NUMBER REQUIREMENT DATA									TANK FUEL INFORMATION							
									SPARK ADVANCE							MAXIMUM				PART-THROTTLE							RATER				
OBS. NO.	TYPE	EMCT	KS	F/A SYS	DSP	TRANS	C.R.	AIR	AS RCD	AS TST	ODOM MILES	AMB TMP	BAROM	HUM	FUEL	OCT NO	GEAR	RPM	VAC	OCT NO	GEAR	RPM	VAC	OWKNK	OCT NO RES	OCT NO MOTR	KNINT	THR	GEAR	RPM	VAC
07-14	T	F	Y	T	5.7	A4	9.1	Y	+ 0	+ 0	16814	76	30.21	20	3	94.0	3U	3450	0.0					N			N				
															2	94.0	2U	3950	0.0												
															4	92.0	3U	3500	0.0												
05-17	T	F	Y	T	5.7	A4	9.1	Y	+ 0	+ 0	7845	70	29.96	50	3	89.0	3U	2200	1.0	F				N	92.3	82.3	N				
															2	92.0	2U	2120	1.0												
															4	87.0	3U	2290	1.0												
25-08	T	E	N	T	5.9	A4	8.1	Y	+10	+10	18280	88	29.43	82	3	88.0	2	1950	0.5	87.0	2	1950	1.5	N	91.8	83.1	N				
															2	89.0	2	1900	0.5												
															4	86.0	2	1950	0.5												
29-29	T	F	Y	T	7.4	A3	7.9	Y	+ 4	+ 4	7302	70	29.30	55	3	86.0	3	1950	1.5	84.0	3	1800	2.5								
															2	87.0	3	1800	1.5												
															4	83.0	2	2000	1.5												

APPENDIX F

PROCEDURES FOR CALCULATING AND PLOTTING OCTANE NUMBER REQUIREMENT DISTRIBUTION DATA

WEIGHTED VEHICLE POPULATIONS

Weighting factors for each model tested were proportioned to the productions and/or sales volumes developed from information supplied by U.S. vehicle manufacturers and from published information (Ward's Automotive Reports) for imports. The weighting factors of each vehicle model were divided by the number of vehicles tested within the model to calculate the individual vehicle weighting factor. The octane requirement for each vehicle were then arranged in increasing order. The percent of vehicles at each octane level is the summation of all vehicle weighting factors with octane requirements lower than that level, plus one-half the sum of the weighting factors at that level. The individual vehicle weighting factors are adjusted so that the summation of all vehicle weighting factors within the population of interest equals 100. Vehicle weighting factors for vehicles with octane requirements lower (L) than the lowest available fuel are assigned to beginning of the distribution while weighting factors for vehicles with octane requirements higher (H) than the highest test fuel are assigned above the highest test fuel octane level. For L and H octane requirements no octane value is used in the computation of octane satisfaction.

Octane satisfaction at population distribution points of interest is interpolated from the above distributions based on numeric octane data and an assumption of normal distribution between the two interpolation points.

DATA ROUND-OFF

The octane number requirements were rounded by the computer to one decimal place. All computations leading to the final rounded values were carried out at the full precision of the computer. In previous surveys the computer rounded requirement data to two decimal places. In preparing report tables the Analysis Panel rounded the computer decimal requirements to one decimal place.

In order to provide consistent treatment comparing 1988 and 1987 survey data, the 1987 data were recomputed and rounded to one decimal place by the computer. This can result in occasional small differences (e.g. $\pm$ 0.1) if a comparison is made using the data in the 1987 survey report.

SELECT CAR MODELS

For individual models, the octane number requirement distribution curves were plotted by the "Z" method as described in "Statistical Estimation of the Gasoline Octane Number Requirement of New Model Automobiles," C. S. Brinegar and R. R. Miller, Technometrics, Vol. 2, No. 1, February 1960.

The procedure is as follows:

For any vehicles having octane requirements lower (L) than the lowest octane number fuel available within a given fuel level, a number 0.5 Research/0.4 Motor lower was assigned. Similarly, for individual vehicles having octane requirements higher (H) than the highest octane fuel available within a given fuel series, a number 0.5 Research/0.4 Motor higher was assigned.

Using all observed and estimated octane number values, calculate the mean (X) and the standard deviation (s) from the data for each model.

$$s = \left[\frac{1}{n-1} \sum_{i=1}^{n} (X - X)^2 \right]^{1/2}$$

Where X_i = Octane number requirement of i^{th} car of a given model

n = Number of cars of that model.

Estimate octane number requirements at the percentiles of interest from octane number requirement distribution data by

$$O.N. = \bar{X} + ks$$

Where k is selected from normal distribution tables.

Values of k used to calculate percentiles in this report are:

Percentile	k
5	-1.645
10	-1.282
20	-0.842
30	-0.524
40	-0.253
50	0
60	+0.253
70	+0.524
80	+0.842
90	+1.282
95	+1.645

APPENDIX G

CONFIDENCE LIMITS OF
OCTANE NUMBER REQUIREMENT DISTRIBUTIONS

CONFIDENCE LIMITS OF OCTANE NUMBER REQUIREMENT DISTRIBUTIONS

Octane number requirements of vehicles presented in this Survey are determined at the levels that satisfy certain percentages of specific vehicle populations. In many cases, the recorded octane number requirement is followed by a plus and minus limit, referred to as the confidence interval. These limits are expected to bound the true requirement of the population represented by the test vehicles 95 percent of the time in replicate testing of the same number of test vehicles.

At the 50 percent satisfaction level, the 95 percent confidence interval is calculated as follows:

$$CI = \pm ts/(n)^{1/2}$$

where t = Students t at the proper number of degrees of freedom*

s = Standard deviation, calculated directly from the data or estimated as the difference between the 84.16th and 50th percentiles (assuming normal distribution)

n = Number of vehicles in population.

At other satisfaction levels:

$$CI = \pm ts \left[1/n + k^2/[2(n-1)]\right]^{1/2}$$

At the 90 percent satisfaction level, k = 1.2817. For other satisfaction levels, appropriate values for k may be found in the standard statistical tables.

Degrees of Freedom**	t	Degrees of Freedom**	t
1	12.706	18	2.101
2	4.393	19	2.093
3	3.182	20	2.086
4	2.776	21	2.080
5	2.571	22	2.074
6	2.447	23	2.069
7	2.365	24	2.064
8	2.306	25	2.060
9	2.262	26	2.056
10	2.228	27	2.052
11	2.201	28	2.048
12	2.179	29	2.045
13	2.160	30	2.042
14	2.145	40	2.021
15	2.131	60	2.000
16	2.120	120	1.980
17	2.110	∞	1.960

* Distribution of t for probability = 0.05.
** Degrees of Freedom = (n-1).

TABLE G-I

95% CONFIDENCE LIMITS FOR PART-THROTTLE OCTANE NUMBER REQUIREMENTS

1990 Weighted Population Groups

Population	Fuel	No. Veh.	t	Standard Dev.			95% Confidence Limits					
							RON		MON		(R+M)/2	
				RON	MON	(R+M)/2	50%	90%	50%	90%	50%	90%
Total 1990 Vehicles												
	PR	22	2.079	3.27	3.27	3.27	1.45	1.98	1.45	1.98	1.45	1.98
	FBRU	249	1.970	3.60	2.33	2.96	0.45	0.61	0.29	0.39	0.37	0.50
	FBRSU	61	2.000	5.67	3.78	4.72	1.45	1.97	0.97	1.31	1.21	1.64
Passenger Cars												
	PR	20	2.092	3.22	3.22	3.22	1.51	2.06	1.51	2.06	1.51	2.06
	FBRU	190	1.973	4.51	2.96	3.73	0.65	0.87	0.42	0.57	0.53	0.72
	FBRSU	53	2.005	5.36	3.56	4.46	1.48	2.00	0.98	1.33	1.23	1.66
Light-Duty Trucks & Vans												
	PR	2	12.705	1.33	1.33	1.33	11.95	19.42	11.95	19.42	11.95	19.42
	FBRU	59	2.000	1.96	1.29	1.62	0.51	0.69	0.34	0.46	0.42	0.57
	FBRSU	8	2.364	8.06	5.47	6.76	6.74	9.38	4.57	6.37	5.65	7.87
Knock-Sensor Vehicles												
	PR	10	2.261	2.23	2.23	2.23	1.59	2.20	1.59	2.20	1.59	2.20
	FBRU	114	1.980	2.87	1.87	2.37	0.53	0.72	0.35	0.47	0.44	0.59
	FBRSU	28	2.051	6.04	4.03	5.03	2.34	3.18	1.56	2.13	1.95	2.65